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BIOLOGICAL STUDIES OF SELECTED REACHES AND TRIBUTARIES OF THE COLORADO RIVER

Federal Water Pollution Control Administration
Cincinnati, Ohio

1968

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BIOLOGICAL STUDIES OF SELECTED REACHES AND TRIBUTARIES OF THE COLORADO RIVER

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TECHNICAL ADVISORY AND INVESTIGATIONS BRANCH
CINCINNATI, OHIO
PREPARED IN COOPERATION WITH THE COLORADO RIVER
BASIN WATER QUALITY CONTROL PROJECT
DENVER, COLORADO
OCTOBER, 1968

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A Report on

BIOLOGICAL STUDIES OF SELECTED REACHES AND TRIBUTARIES OF THE COLORADO RIVER

United States Department of the Interior
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
Technical Advisory and Investigations Branch
Cincinnati, Ohio

Prepared in Cooperation With
The Colorado River Basin Water Quality Control Project
Denver, Colorado

1968

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FOREWORD

This report fulfills the request of the Colorado River Basin Project, Denver, Colorado, to determine the effects of municipal and industrial wastes on the aquatic life in selected waters of the Colorado River Basin. These studies were conducted with the assistance of personnel from the Colorado River Basin Project.

PARTICIPANTS

Biological field investigations during 1966 on the waters of the Colorado River Basin were conducted jointly by the Technical Advisory and Investigations (TA&I) Branch and the Colorado River Basin Project. Samples for water chemistry were analyzed either in mobile laboratories at Farmington, New Mexico, or at Grand Junction, Colorado, or preserved and shipped to the TA&I laboratory in Cincinnati, Ohio.

Personnel involved in the biological field studies were: Chris Anderson, Colorado River Basin Project, Phoenix, Arizona, and Loys P. Parrish, R. Keith Stewart, and Nelson A. Thomas, biologists, Technical Advisory and Investigations Branch, Cincinnati, Ohio.

Mr. Nelson Thomas was in charge of the biological field studies and prepared this report.

CONCLUSIONS

GENERAL

1. Biological studies were conducted in 1966 on 921 miles of the Colorado River system, including parts of the main stream and those tributaries that are interstate waters. These studies showed that wastes from municipalities, mining activities and gravel operations seriously degraded the aquatic life inhabiting 83 miles of interstate waters. Also studied were 581 miles of intrastate streams in the Colorado River system, of which 97 miles were seriously degraded for aquatic life by man's activities.
2. All facets of aquatic life were adversely affected in the Colorado River Basin by various wastes. Data on specific stream reaches follow conclusions on specific streams.
    a. Mining and ore processing activities discharged toxic metals, chemicals and mine drainage that eliminated algae, bottom organisms and fish.
    b. Municipal discharges supplied nutrients that promoted massive slime growths and over-production of algae. Organic solids in these discharges degraded populations of bottom organisms.
    c. Irrigation water returns raised the temperature of the receiving streams sufficiently to replace coldwater

fish such as trout with warmwater fish such as bass.

d. Industrial activities, such as sugar processing plants, discharged silt and sludge to Basin streams in sufficient quantities to degrade aquatic life.

3. Silt from gravel operations connected with construction activities also had a deleterious effect on several Basin streams.

SPECIFIC STREAMS

1. Discharges of toxic metals from the Wilfley and other metal ore mines eliminated bottom organisms and trout from 8 miles of Tenmile Creek downstream from Climax, Colorado, and reduced trout populations in an additional 12 miles of Tenmile Creek from West Tenmile Creek downstream to Dillon Reservoir.
2. Elimination of bottom organisms in an 8-mile reach of Eagle River was caused principally by drainage from the old pond of the New Jersey Zinc Corporation located one mile downstream from Gilman, Colorado, and partially by drainage from new ponds. These wastes destroyed fish food and created an environment unsatisfactory for the propagation of trout and other fish.
3. Organic wastes discharged from small drains to Roaring Fork River as it flows through Aspen, Colorado, increased the population of pollution-tolerant sludgeworms. This reduction in the population of fish food organisms for six miles downstream

from the Aspen sewage treatment plant reduced the production of trout.

4. At Grand Junction, Colorado, degradation of the Colorado River resulted from discharges from the East Side sewage treatment plant, Climax Uranium Mill, and especially the West Side sewage treatment plant. These wastes completely eliminated all fish food organisms in a one-mile reach, and adversely affected an additional seven miles of the Colorado River downstream from Grand Junction, Colorado. Wastes from the West Side plant produced sewage fungus (*Sphaerotilus natans*), other slime growths, and covered the stream bed with an oil slick. At Loma, Colorado, 18 miles downstream from Grand Junction, the river recovered biologically.

5. Drainage from the Keystone Mill at Crested Butte, Colorado, severely reduced the population of bottom organisms in Coal Creek. This reduction also indicated that the stream is uninhabitable for trout, thus depriving the community of a reach of stream that could provide trout fishing.

6. Raw sewage from the municipality of Paonia, Colorado, eliminated the pollution-sensitive fish food organisms and increased the numbers of pollution-tolerant sludgeworms in a 3-1/2-mile reach of the North Fork of the Gunnison River.

7. Wastes discharged from the municipality of Hotchkiss, Colorado, to the North Fork of the Gunnison River reduced the diversity

of bottom organisms, indicating a degraded condition. The population of bottom organisms recovered 7.5 miles downstream from Hotchkiss.

8. Silt and sludge discharged from the Holly Sugar Company at Delta, Colorado, suppressed the population of bottom organisms in the Gunnison River immediately downstream from the discharge. The population was affected adversely for an additional 10 miles as indicated by the reduction of pollution-sensitive stoneflies and mayflies, and an increase in the pollution-tolerant sludgeworms and intermediate-tolerant midges.

9. Silt resulting from the gravel washing operation on the Cimarron River at Highway 50, near Cimarron, Colorado, has degraded the aquatic life inhabiting a 2-mile reach. Deposits of silt, resulting from gravel washing operations prior to the construction of ponds, were resuspended when the flow increased. This resulted in the reduction of bottom organisms with a subsequent loss of fish food. The aquatic life also was affected adversely by the covering of fish-spawning beds with silt.

10. Mine drainage and natural runoff entering Red Mountain Creek upstream from Ouray, Colorado, contained high metals concentrations that destroyed aquatic life in this stream and in a 10-mile reach of the Uncompahgre River downstream from the mouth of Red Mountain Creek. Canyon Creek, a tributary to the Uncompahgre at Ouray, received a heavy sediment load that

covered the stream bed sufficiently to suffocate bottom organisms. Effects of this sediment on the Uncompahgre River downstream from Ouray could not be determined because acid mine drainage had eliminated upstream populations of fish and bottom organisms.

11. The diversion of water at Montrose and Olathe, Colorado, and irrigation return flows during the summer increased water temperature, turbidity, and the dissolved solids concentration in the Uncompahgre River producing an environment unsuitable for bottom organisms and trout. The water temperature at Olathe reached 83° F which exceeds the thermal tolerance level for both brook and rainbow trout.

12. Silt from a gravel operation on the Dolores River upstream from Rico, Colorado, degraded at least 23 miles of stream. This included a severe reduction in the population of trout-food bottom organisms. Moreover, the silt covered the potential spawning grounds of trout.

13. Mine drainage directly to Marshall Creek, Savage Creek, and San Miguel River upstream from Telluride, Colorado, eliminated all aquatic organisms in these streams. Damage to the aquatic life extended 2 miles downstream from the Idarado mine 1 mile upstream from Telluride.

14. Mine drainage to Howard Fork near Ophir, Colorado, reduced the population of bottom organisms for a distance of 5 miles, but did not completely eliminate them.

15. Drainage from the paint pigment iron quarry near Ophir, Colorado, eliminated all stream bed organisms except the midge, *Brillia sp*. The stream was unsuitable for the propagation of trout for a distance of approximately 2 river miles.

16. The San Miguel River at Uravan, Colorado, was degraded for approximately 2 miles by the discharge of toxic wastes from the Union Carbide Company. However, as a result of better waste treatment, the population of bottom organisms had improved during the past four years in the 2-mile reach downstream from the mill.

17. In the Dolores River, downstream from Bedrock, Colorado, to its confluence with the San Miguel River, the population of bottom organisms was eliminated by the natural drainage from springs containing large quantities of chlorides and sulfates.

18. The aquatic life inhabiting the Price River was degraded by natural runoff and the discharge of organic wastes from the municipalities of Price and Wellington, Utah. Sediment from natural runoff covered the stream bed and eliminated pollution-sensitive organisms. Municipal discharges supplied food for increased numbers of pollution-tolerant sludgeworms.

19. Mine drainage to the Animas River, upstream from Silverton, Colorado, and to its tributary, Cement Creek, eliminated the

populations of bottom organisms and trout in this interstate stream for several miles downstream from Silverton.

20. The population of bottom organisms inhabiting McElmo Creek, an interstate stream between New Mexico and Utah, was composed of pollution-tolerant organisms. The effluent from the Cortez, Colorado, sewage treatment plant comprised the majority of the flow.

21. The substrate of the Colorado River in the Pierce Canyon, Utah, reach was unsuitable for the development of a population of bottom organisms because of silt and shifting sand. The low population of phytoplankton in the Colorado River was caused by the action of large quantities of suspended silt. The Colorado River contributed approximately 62% of the soluble phosphorus by weight, and 98% of the flow to Lake Mead. A channel catfish sport fishery existed in the Colorado River upstream from Lake Mead.

22. The Virgin River, an interstate stream between Utah and Nevada, was not degraded by the activities of man but rather from runoff which transports fine silts. Silts reduced the populations of bottom organisms from Littlefield, Arizona, to Lake Mead, a total of 70 miles. The phytoplankton population was limited to 100 organisms/ml at St. George, Utah, as a result of high turbidities from runoff. The Virgin River provided 1.5% of the flow and 2% of the soluble phosphorus to Lake Mead.

23. Nutrients entering Lake Mead from the intrastate Las Vegas Wash were of sufficient quantity to produce algal concentrations exceeding 39,300/ml at the surface in the immediate vicinity of the mouth of the Wash. Algal concentrations in the lake decreased with distance from the mouth of the Wash. The algal populations near the Henderson-Las Vegas water supply intake and the Boulder City intake were characteristic of Lake Mead surface waters and were not influenced by the algal populations produced by the nutrients discharged from Las Vegas Wash.

24. Las Vegas Wash contributed approximately 0.2% of the flow and 35% of the soluble phosphorus to Lake Mead. The contributions of soluble phosphorus by the Las Vegas and Clark County sewage treatment plants during the survey of the Colorado River from Lake Mead to the Mexican Border were the most significant source of man-made pollution affecting water uses.

25. Wastes from the intense boating and camping activities in the reach of the Colorado River from Parker Dam to Parker, Arizona, did not adversely affect the population of bottom organisms.

26. The population of bottom organisms in the downstream reach of the Colorado River Indian Reservation irrigation system, which received return irrigation water, was affected adversely by increased quantities of silt and decreased velocity. The phytoplankton population increased but not to an extent that it

interfered with water usage. Soluble phosphorus increased fivefold and the total phosphorus increased tenfold. The inorganic nitrogen concentration remained approximately the same through the canals.

27. The population of bottom organisms in the Palo Verde return drain contained the same types of organisms as the inlet canal, and at similar densities. Phytoplankton populations, responding to a fivefold increase of soluble phosphorus from irrigation returns, increased 2.5 times while the attached algal populations increased 20 times. No significant change was observed in the concentration of inorganic nitrogen.

28. Fifteen miles upstream from Yuma, Arizona, the increase in the population of bottom organisms in the Colorado River downstream from Laguna Dam resulted from a threefold increase in the algal population that provided their food.

29. Raw sewage from the City of Yuma, Arizona, adversely affected the population of bottom organisms in the Colorado River for approximately 2 miles. The phytoplankton population was not affected by the wastes because of swift waters. The soluble phosphorus concentration remained at the same level throughout the reach, but the total phosphorus increased fourfold. The inorganic nitrogen concentration remained unchanged. The fishery is limited by the large quantities of silt from the All American siltation basins entering the river in the reach near Imperial Dam.

SUMMARY

DEGRADATION OF SPECIFIC STREAMS

Reach of Water	Principal Type of Wastes*	Stream Miles of Interstate		Stream Miles of Intrastate	
		Examined	Adversely Affected	Examined	Adversely Affected
Tenmile	Toxic metal and mine drainage			20	20
Eagle	Toxic metals			58	8
Roaring Fork	Municipal			48	6
Colorado Cameo, Col. - Moab, Utah	Chemical-metals and Municipal	124	8		
Slate	Mine drainage and toxic metals			10	2
Gunnison	Sugar beet			149	11**
North Fork	Municipal			18	3.5
Cimarron	Gravel Borrow			6	2
Uncompahgre	Mine drainage and toxic metals Irrigation			76	17 12
Dolores-Upper	Gravel Washing	42	23		
Dolores-Lower	Chemical	77	2		
San Miguel	Mine Drainage and Iron Pigment Quarry			79	7
Price	Municipal			117	10
San Juan	Municipal	204	2		
Animas	Mine drainage and toxic metals	115	20+		
McElmo	Municipal	50	15		

Reach of Water	Principal Type of Wastes*	Stream Miles of Interstate		Stream Miles of Intrastate	
		Examined	Adversely Affected	Examined	Adversely Affected
Colorado Pierce Can. to Lake Mead		12	0		
Virgin	Municipal	109	0		
Muddy	Municipal	23	0		
Las Vegas Wash	Municipal	11	11		
Lake Mead	Nutrients		Las Vegas Arm		
Havasu L.	(camping & boating) Recreational		0		
Colorado Parker Dam-Parker, Ariz.	(camping & boating) Recreational	59	0		
Colorado River Indian Reservation	Irrigation	50	50**		
Palo Verde Irrigation	Irrigation	38			
Colorado Yuma-Morelos Dam	Municipal	7	2		
	Total	921	171	581	97

*For additional information, see PR-16

**Degradation not severe

BACKGROUND INFORMATION

The Colorado River Basin Water Quality Control Project was established as a result of recommendations made at the first session of a joint Federal-State "Conference in the Matter of Pollution of the Interstate Waters of the Colorado River and Its Tributaries" held at Phoenix, Arizona, in January 1960 under the authority of Section 8 of the Federal Water Pollution Control Act (33 U. S. C. 466 et. seq.).* This conference was called at the request of the States of Arizona, California, Colorado, Nevada, New Mexico, and Utah to consider water pollution problems in the Colorado River and its tributaries.

Long-Range Goal and Objectives

The long-range goal of the Colorado River Basin Water Quality Control Project is the improvement of water quality in the Colorado River Basin and its water service area in southern California. In working toward this goal, the Project is undertaking field investigations, together with engineering and economic studies to accomplish the following objectives:

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*Since January 1960, the Federal Water Pollution Control act has been amended by the Water Quality Act of 1965 - (PL 89-234). The provisions of Section 8 of the Federal Water Pollution Act existing in 1960 (PL 87-88) were incorporated in Section 10 of the 1965 Water Quality Act. On May 10, 1966 under provisions of the President's Reorganization Plan No. 2 of 1966 the responsibility for administering the Federal Water Pollution Control Act was transferred from the U. S. Department of Health, Education, and Welfare to the U. S. Department of the Interior.

INTRODUCTION

GENERAL

Biological studies were conducted in 1966 on selected reaches of rivers within the Colorado River Basin. The habitat for aquatic life was highly varied because of extreme differences in water quality caused by pollutants from mineral milling operations, municipalities, oil refineries, natural mineral springs, runoff, mine drainage and irrigation return waters.

BOTTOM ORGANISMS

A biological investigation determines kinds and quantity of aquatic life in a stream. Stream bed organisms that have life cycles of one year or longer are especially suited to evaluating the effects of water quality because they reflect bottom conditions over a period of several months. Many factors, including: (a) light; (b) temperature; (c) dissolved gases; (d) toxic materials; (e) food; (f) type of bottom substrate; (g) depth of water; and (h) current velocity affect the number, as well as the kinds of organisms that inhabit the aquatic environment. A change in any of these factors will change the biotic community.

Rock and coarse gravel offer the most suitable bottom habitat to many organisms; decreasing bottom organism productivity is correlated with decreasing particle size of the substrate. Fine sand,

(1) To determine the location, magnitude, nature, and causes of interstate pollution of the Colorado River and its tributaries.

(2) To determine and evaluate the nature and magnitude of the damages to water users caused by radioactivity, salinity, and other types of pollution.

(3) To develop and evaluate methods to control or minimize this pollution.

(4) To recommend control or other measures justified by the benefits, economic or otherwise, that will accrue from improved water quality.

These biological studies were conducted to provide information on objectives 1 and 2.

because of its small interstitial spaces and shifting nature, offers little habitat to organisms.

Most bottom organisms do not move great distances; thus, they are subjected to all adverse factors entering the area. Water quality changes destroy some organisms; others can tolerate severe environmental changes. Organic pollution, for example, may cover the stream bed with sludge, increase the food supply drastically and decrease the dissolved oxygen. These environmental changes are enough to eliminate desirable pollution-sensitive immature stoneflies, caddisflies, and mayflies. Because of decreased predation and abundant food supply, pollution-tolerant sludgeworms and certain midges multiply in great abundance.

An unpolluted stream in the Colorado drainage area often supports 20 different kinds of organisms in one reach, 10 or more of these being types associated with clean waters. A stream carrying organic wastes supports a large population of bottom organisms composed of only two or three kinds, all of them pollution-tolerant and undesirable to fish as food.

Inorganic silt covers the stream bottom and eliminates living spaces for bottom organisms. Silt does not offer a rich food supply but instead suppresses production of all forms of bottom organisms.

Toxic materials, such as metals, suppress and often eliminate all forms of bottom organisms.

METHODS

Three types of bottom samplers were used; the Ekman dredge, the Petersen dredge, and a Surber square-foot sampler. All of these are described in the twelfth edition of "STANDARD METHODS for the Examination of Water and Wastewater."* In addition, the square-yard sampler was used on the Animas River from Durango, Colorado, to Farmington, New Mexico, to compare results from the 1966 survey with studies conducted in 1958. This sampler consisted of a square yard of window screen (14 meshes to the inch) attached to 2 wooden poles. The sampler was placed perpendicular to the streamflow, and a square yard of bottom, upstream from the net, was scraped clean of organisms which drifted onto the screen. The results obtained from the Ekman and Petersen dredges were multiplied by appropriate correction factors so that their results could be expressed in number of organisms per square foot. The results from the Surber square-foot and the square yard samplers were left as counted.

A qualitative and usually 2 quantitative samples were obtained from each station.

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* Anon. 1960. STANDARD METHODS for the Examination of Water and Wastewater. Twelfth Edition, American Public Health Association, Inc. New York, 769 pp.

ALGAL STUDIES

To determine the effects of wastes on algal productivity, 1 x 3 inch microscope slides were placed in the streams for a 10-day period. After removing from the stream, the slides were immersed in a formaldehyde solution and transported to the laboratory for analyses. In the laboratory the algae on the slides were scraped into a known volume of water to provide a suspension which could be subsampled for enumeration in a Sedgwick-Rafter cell.

FISH

A variable voltage D. C. fish shocker was employed on those rivers where netting was not practical. The fish thus captured were reported along with the shocking time and the distance of the river sampled.

A 2-frame, 5-hoop trap net without wings, measuring 10 feet long, 2.5 feet deep and 3.5 feet wide with a stretch mesh size of 1/2 inch, was used at most of the fish sampling stations. These nets were fished with the opening downstream for 4 net-days of fishing at each station.

CHEMICAL METHODS

Water samples for mineral analyses were preserved with a concentration of 1 ml of sulfuric acid per liter of sample. The metals iron, chromium, manganese, zinc, copper, molybdemum, and lead were determined by atomic absorption employing the methods outlined in Perkin-Elmer's manual of ANALYTICAL METHODS FOR ATOMIC ABSORPTION SPECTROPHOTOMETRY. Standard operating conditions for each individual metal were followed with no pretreatment of the sample, except in the case of lead. In the analysis of lead, a known quantity of the sample was passed through an ion-exchange column containing Dowex 50W-X4 resin, and eluting the column with 25 ml of 2-molar sulfuric acid. This procedure is discussed in "Atomic Absorption Newsletter," May 1954, Number 20. Field determinations of metals were made on many of the samples to obtain base line information. These were made with a portable direct reading field kit.

DISCUSSION OF STREAM SURVEYS

TENMILE CREEK, COLORADO

A survey was conducted on Tenmile Creek from Climax to Frisco, Colorado, on October 14, 1966, to determine the effects of mining and milling wastes on aquatic life.

Tenmile Creek heads near Climax, Colorado, and is formed by drainage from Mayflower Gulch, Clinton Gulch, and Searle and Kokoma Creeks. The Climax Molybdenum Plant has water rights on all of these streams, diverting nearly the entire flow for water supply. The flow of Tenmile Creek derives mainly from Searle Creek, and in lesser amount from Climax Molybdenum pond seepage.

Upstream from diversions, all headwater streams supported clean-water associated organisms such as stoneflies, mayflies, and caddisflies. These organisms are food for trout.

Searle Creek, the only headwater stream reaching Tenmile Creek, supported 13 kinds of organisms including stoneflies, mayflies, caddisflies, and beetles, with a population density of 132 organisms per square foot upstream from the Wilfley mine. No aquatic life was present downstream from the diversions because of drainage from the Wilfley mine. The stream bed was covered with a heavy iron precipitate, "yellow boy;" rocks were almost solidified into a single mass. Chemical water analyses here (T-4) showed: total iron, 1.1 mg/l;

manganese, 1.4 mg/l; and zinc, 6.8 mg/l (Table 2). Singly or in combination, these concentrations of metals could eliminate aquatic life.

Tenmile Creek, downstream from Searle Creek supported only 1 type of midge in a low population; farther downstream no aquatic organisms were found. Zinc, in concentrations exceeding 0.38 mg/l, was the major mine drainage constituent that eliminated aquatic life in Tenmile Creek from the mouth of Searle Creek downstream to the confluence with West Tenmile Creek, a distance of about 8 miles.

Tenmile Creek began to recover biologically in the 12-mile reach from West Tenmile Creek to Dillon Reservoir. Just upstream from the town of Frisco, Colorado, Tenmile Creek supported only 22 organisms per square foot (Figure 1) represented by 6 kinds (Figure 2). A population of this low number indicates presence of a toxicant. At station T-12, 11 kinds of organisms with a density of 58 per square foot were found. This was far less than observed in the tributary streams near Climax or in West Tenmile Creek. Such a population of bottom organisms indicates that mine drainage entering Tenmile Creek in the Climax area rendered the stream unsuitable for the propagation of trout and fish food organisms, thus depriving local communities of a valuable trout fishery. The 0.17 mg/l of zinc in Tenmile Creek, as it enters Dillon Reservoir (T-12), appeared to limit aquatic life.

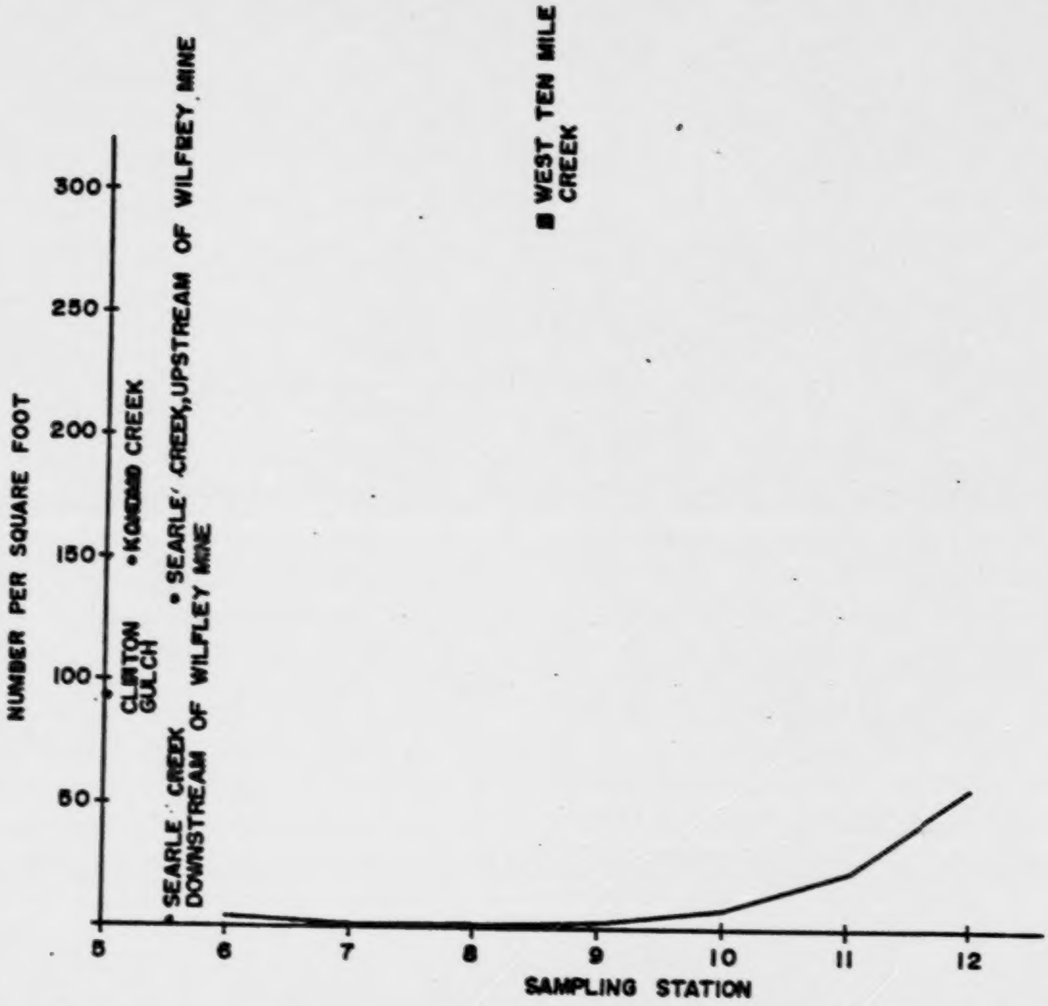


FIGURE I. TEN MILE CREEK, NUMBER OF BOTTOM ORGANISMS PER SQUARE FOOT, OCTOBER, 1966.

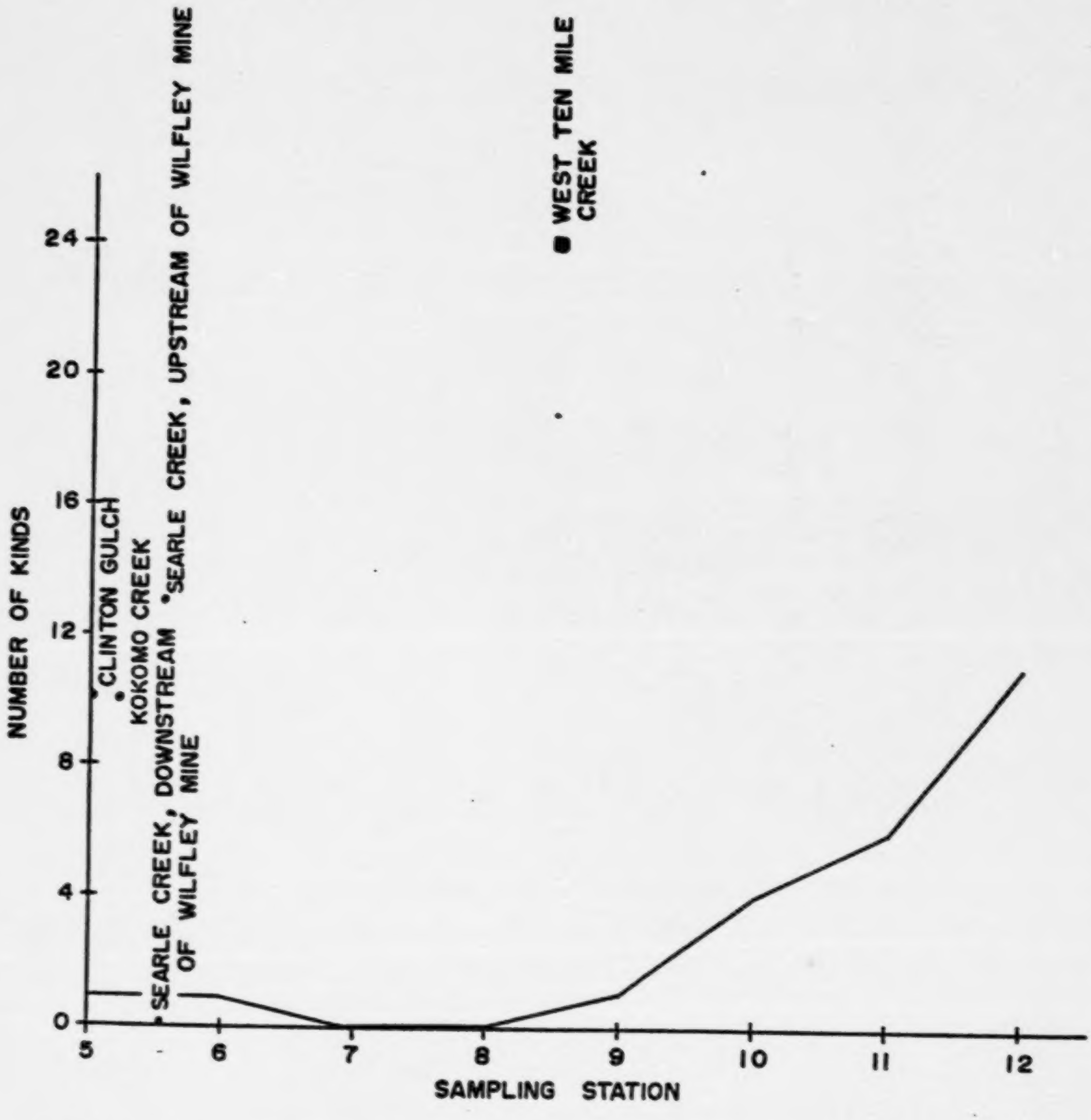


FIGURE 2. TEN MILE CREEK, NUMBER OF KINDS OF BOTTOM ORGANISMS, OCTOBER 1966.

In summary, drainage from the Wilfley and other mines eliminated the populations of bottom organisms and trout in 8 miles of Tenmile Creek from Climax, Colorado, to the stream's confluence with West Tenmile Creek (Figure 39). From this point, excessive levels of zinc keep the populations of bottom organisms and fish at reduced levels in the 12 miles from the mouth of West Tenmile Creek downstream to Dillon Reservoir.

EAGLE RIVER, COLORADO

The Eagle River heads 20 miles south of Redcliff, Colorado, on the western slope of the Rocky Mountains and empties into the Colorado near Dotsero, Colorado. During the October 5 and 6, 1966, survey, wastes included: (a) municipal discharges to Eagle River from Redcliff and Minturn; (b) drainage from the New Jersey Zinc Corporation's old holding ponds; (c) drainage from the New Jersey Zinc Corporation's present ponds into Cross Creek, a tributary to the Eagle River; and (d) drainage from an abandoned mine located on property of the New Jersey Zinc Corporation.

The two streams that form the Eagle River are clean, gravelly-bed trout streams that support respectively 11 and 14 kinds of organisms in populations of 132 and 66 per square foot. At least 8 kinds were pollution-sensitive stoneflies, mayflies, and caddisflies (Table 4). This assemblage of organisms not only indicates unpolluted waters, but also is an abundant source of fish food. Wastes from Redcliff did not degrade the population of bottom organisms in Eagle

River; downstream from Redcliff's waste discharge there were 19 species with 387 organisms per square foot (Figure 3). An increase in the waste discharge, or a decrease in streamflow, could affect adversely bottom organisms by providing a food supply for the more pollution-tolerant organisms and forcing out the desirable clean-water organisms.

Downstream from Redcliff, Homestake Creek flows into Eagle River; it supported a diverse population of 14 kinds of organisms, 10 of which were clean-water types (Figure 4). However, silt from construction activities upstream was present among the rocks of the stream bed, reducing the flow of water through the gravel and interfering with the hatching of trout eggs.

Two miles downstream from the confluence with Homestake Creek, the population of bottom organisms in Eagle River had decreased from 15 to 9 kinds and from 202 to 77 organisms per square foot. This reach of river receives a small amount of drainage from an old abandoned mine located on property of the New Jersey Zinc Corporation. Chemical data showed an increase in zinc concentration from 0.02 to 0.13 mg/l.

The old holding ponds, 2 miles downstream from the New Jersey Zinc Corporation, contributed a small discharge to the river. The greatest portion of the waste effluent from the plant is transported to new ponds, 1-1/2 miles farther downstream. The discharge from the old ponds was extremely toxic, containing 38 mg/l of iron,

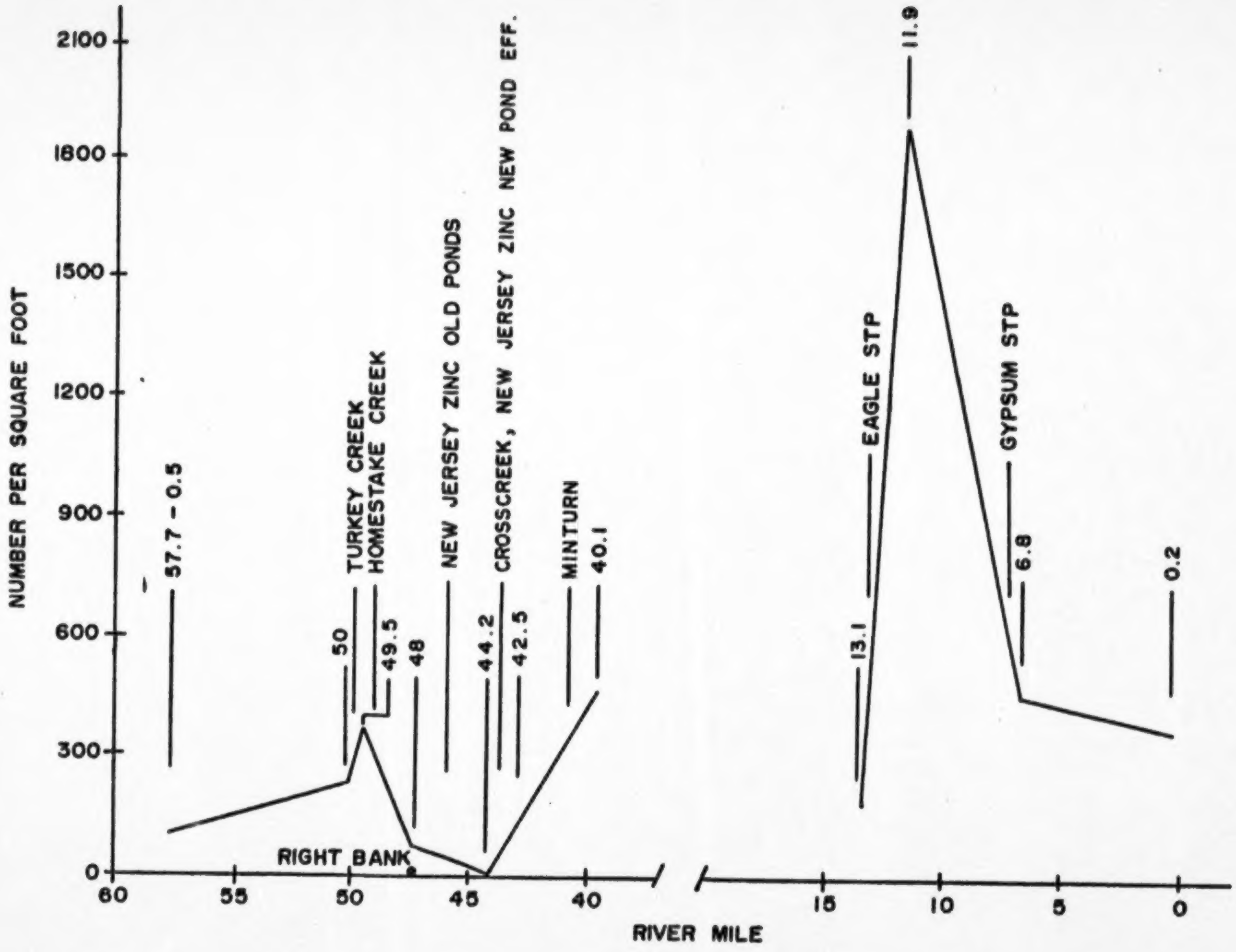


FIGURE 3. EAGLE RIVER, NUMBER OF BOTTOM ORGANISMS PER SQUARE FOOT, OCTOBER 1966.

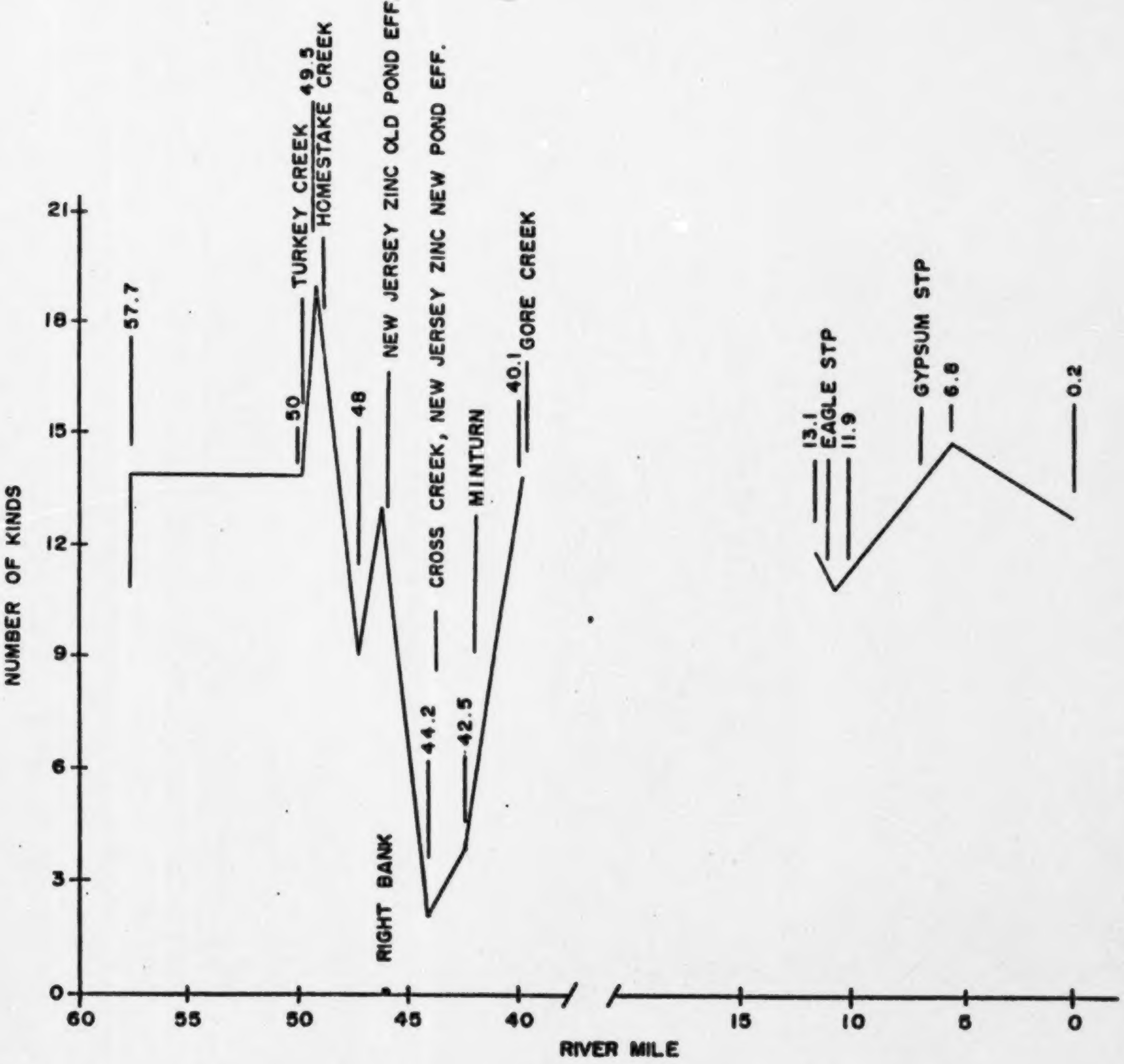


FIGURE 4. EAGLE RIVER, NUMBER OF KINDS OF BOTTOM ORGANISMS OCTOBER 1966.

10.6 mg/l of manganese, 4.1 mg/l of zinc, and 0.1 mg/l of copper. These combined metals eliminated all bottom life along the side of Eagle River receiving the discharge. Toxicity persisted for 2 miles downstream. The chemical analyses at this station showed iron and zinc concentrations of 1.6 mg/l, and 0.31 mg/l respectively.

The bed of Eagle River downstream from the old ponds to the confluence of Castle Creek was virtually cemented with "yellow boy," an iron precipitate. This substance precludes any development of bottom organism populations or use of the stream bottom for fish spawning.

Just upstream from Minturn, Colorado, the effluent from the new ponds enters Cross Creek reducing the bottom organism population of that stream from 14 to 8 kinds and from 158 to 15 per square foot and affecting water quality in Eagle River.

Biological recovery was complete 2 miles downstream from Minturn, where Gore Creek joins Eagle River. In this reach the Eagle River supported 14 kinds of organisms, 10 of which were pollution-sensitive. Total iron was 0.9 mg/l; manganese, 1.6 mg/l; and zinc, 0.57 mg/l.

The effluent from the Eagle, Colorado, sewage lagoons enters the river 25 miles downstream from Gore Creek. The density of pollution-sensitive bottom organisms that formedthe major diet for trout increased from 214 to 1,835 per square foot as a result. Under decreased flows, however, the pollution-tolerant group could increase and the pollution-sensitive ones decrease.

The Eagle River, just upstream from its confluence with the Colorado River, supported an assemblage of bottom dwelling organisms that was indicative of unpolluted conditions.

In summary, drainage from an old abandoned mine and the old disposal ponds of the New Jersey Zinc Corporation completely eliminated bottom dwelling organisms, indicating that Eagle River water would be toxic to higher forms of aquatic life, such as trout. This degradation continued for 8 miles and is supplemented by wastewater discharges from the corporation's new tailings ponds into Cross Creek, a tributary of Eagle River (Figure 39). The elimination of trout in the 8-mile reach economically deprives the community of Minturn of a valuable resource. This 8-mile, toxic zone could also present a barrier to fish migration, not only during their spawning run, but also during other periods of the year. Eagle River recovered biologically two miles downstream from Minturn.

ROARING FORK RIVER, COLORADO

The Roaring Fork River is noted as a famous trout fishery and, in the reach from Aspen downstream to Woody Creek, Colorado, only fly fishing is allowed. Wastes from the Aspen Consolidated Mining Company are discharged to tailing ponds adjacent to Hunter Creek, a tributary to Roaring Fork River. During the survey no discharge from the ponds was observed. although a small amount of underground seepage was evident along the reach of Hunter Creek adjacent to the ponds.

Roaring Fork, upstream from the Aspen Sanitation District sewage treatment plant and the confluence of Hunter Creek, supports a population of bottom organisms numbering 398 per square foot, with a diversity of 20 species predominated by the pollution-sensitive mayflies, stoneflies, and caddisflies (Table 6, Figures 5 and 6). The presence of 103 sludgeworms per square foot within this assemblage of organisms indicates that some organic enrichment of the river occurs as it flows through Aspen, Colorado. Downstream from the sewage treatment plant, the kinds of bottom organisms decreased slightly, while the numbers per square foot increased to 696, indicating that waste discharges were sufficient to eliminate some of the pollution-sensitive organisms and provide food for the more tolerant forms. Further degradation of Roaring Fork River attributable to wastes from the Aspen sewage treatment plant was evident in the near elimination of all pollution-sensitive organisms two miles downstream. The stream bed and waters at the sampling station on Hunter Creek (St. 1199-43-1.2), downstream from the mining operation,

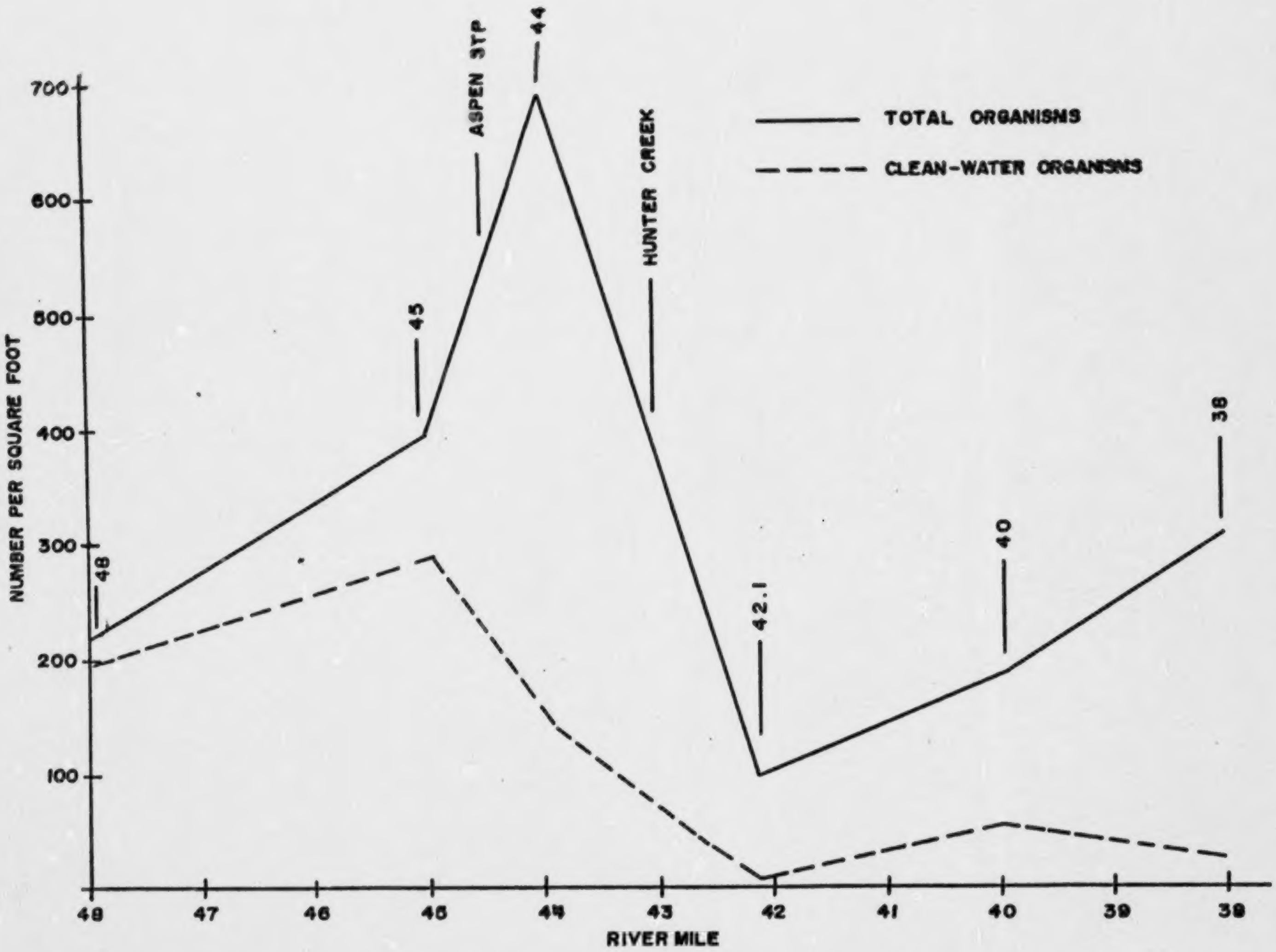


FIGURE 5. ROARING FORK, NUMBER OF ORGANISMS PER SQUARE FOOT, OCTOBER 1966.

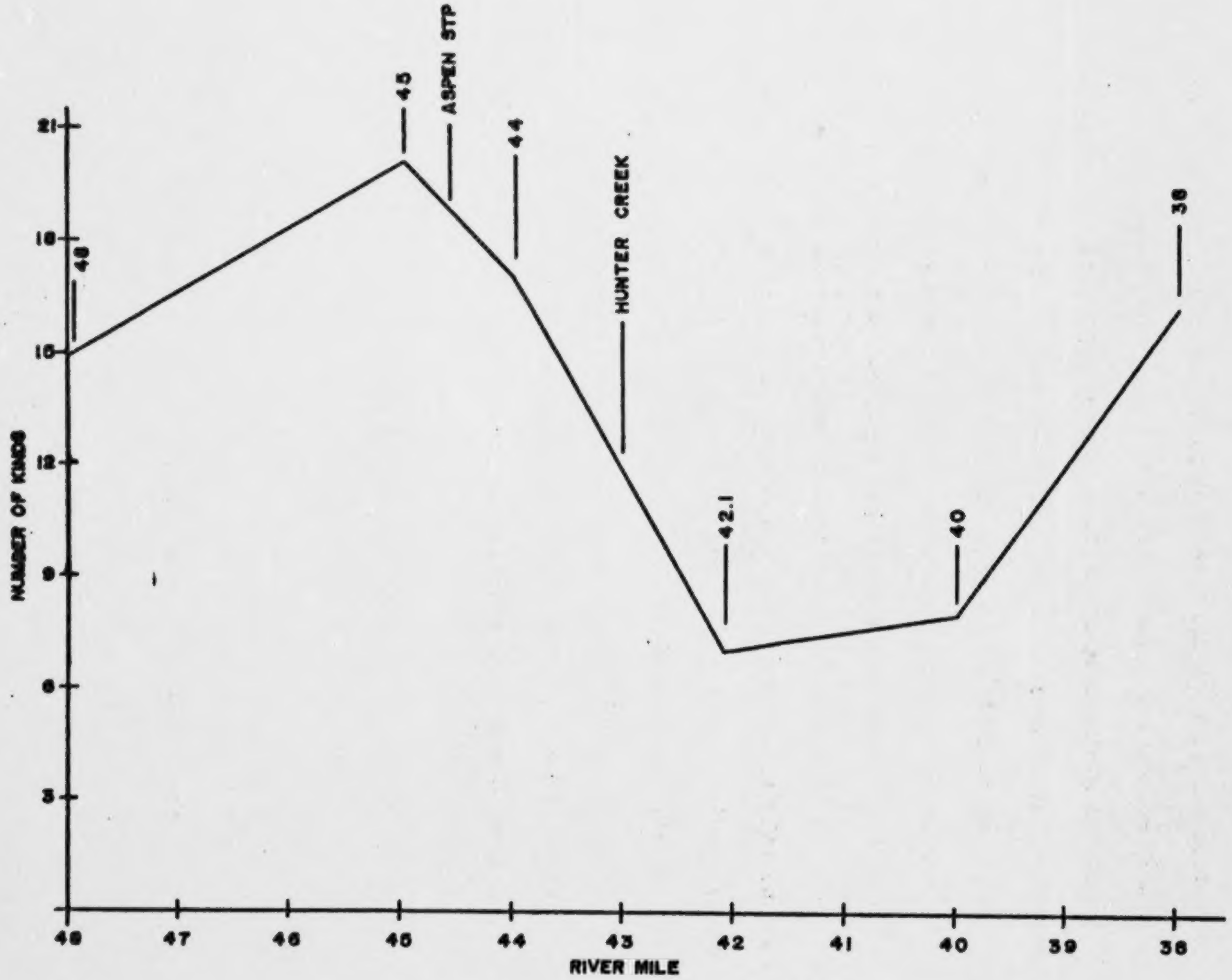


FIGURE 6. ROARING FORK, NUMBER OF KINDS OF BOTTOM ORGANISMS, OCTOBER 1966.

supported a bottom organism population numbering 158 per square foot with a diversity of 13, of which seven were pollution-sensitive organisms.

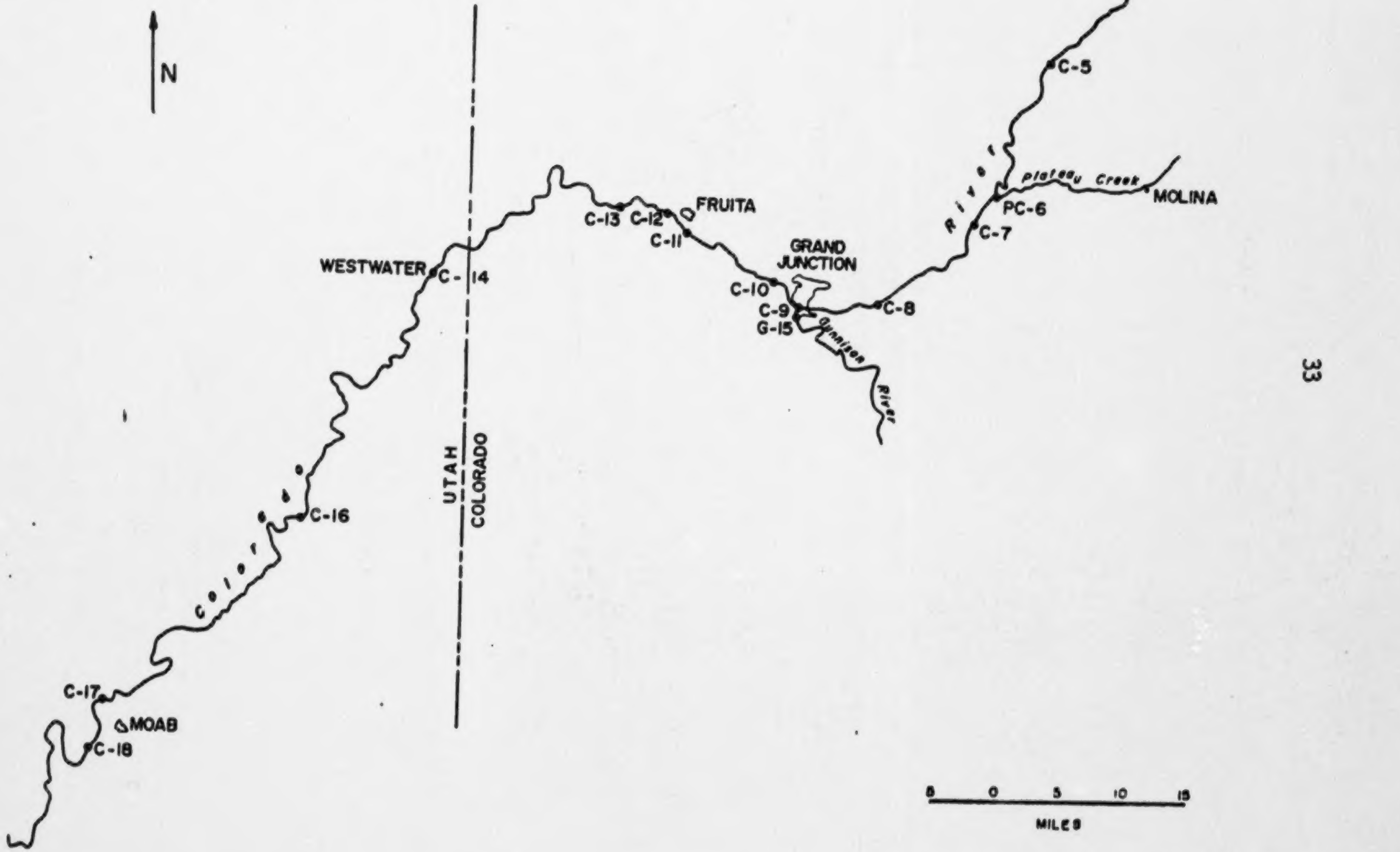
In summary, the Roaring Fork River, upstream from the Aspen Sanitation District sewage treatment plant, received organic wastes from unidentified sources. Hunter Creek, upstream and downstream from the Consolidated Mining Company tailings ponds, supported a population of bottom organisms typical of an unpolluted stream. Aquatic life in Roaring Fork River two miles downstream from the Aspen sewage treatment plant was severely degraded, as evidenced by the observed reduction in prime fish food, such as stoneflies, mayflies, and caddisflies, and the increase in intermediate pollution-tolerant organisms, such as midges. Consequently trout production has been decreased in a six-mile reach of the Roaring Fork River (Figure 39).

COLORADO RIVER, COLORADO-UTAH

At Cameo, Colorado, the Colorado River supported aquatic life indicative of an unpolluted river, with 96 percent of the total numbers of organisms clean-water mayflies and caddisflies (Table 8). Ten miles downstream at Clifton, the bottom organism density increased from 87 to 534 per square foot reflecting the productivity stimulated by food from waste discharges.

At Grand Junction, Colorado (Station C-9), the main channel of the Colorado River was not affected by South Side sewage treatment plant wastes and the Climax Uranium Mill. Bottom organisms here numbered 941 per square foot with 12 kinds represented. Seven species were pollution-sensitive mayflies and caddisflies. The left bank at Station C-9

FIGURE 7.
STUDY AREA
COLORADO RIVER SYSTEM


N
RIFLE
RC-2
C-3
C-1
C-4
C-5
River
Plateau Creek
MOLINA
PC-6
C-7
GRAND JUNCTION
C-8
C-10
C-9
G-15
Gunnison River
FRUITA
C-13
C-12
C-11
WESTWATER
C-14
UTAH
COLORADO
C-16
Colorado
C-17
MOAB
C-18
5
0
5
10
15
MILES

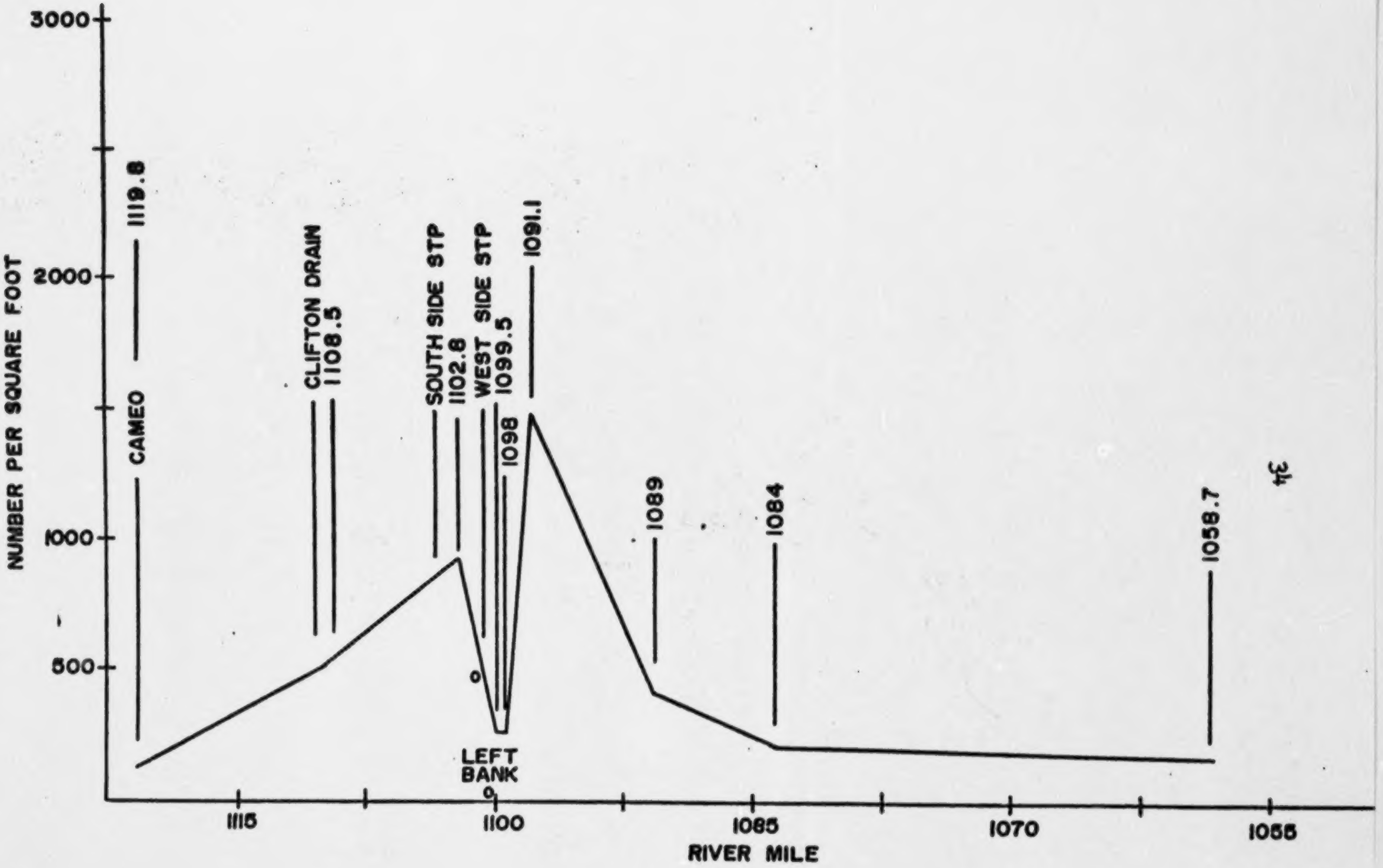


FIGURE 8. COLORADO, NUMBER PER SQUARE FOOT OF BOTTOM ORGANISMS, JULY-AUGUST 1966

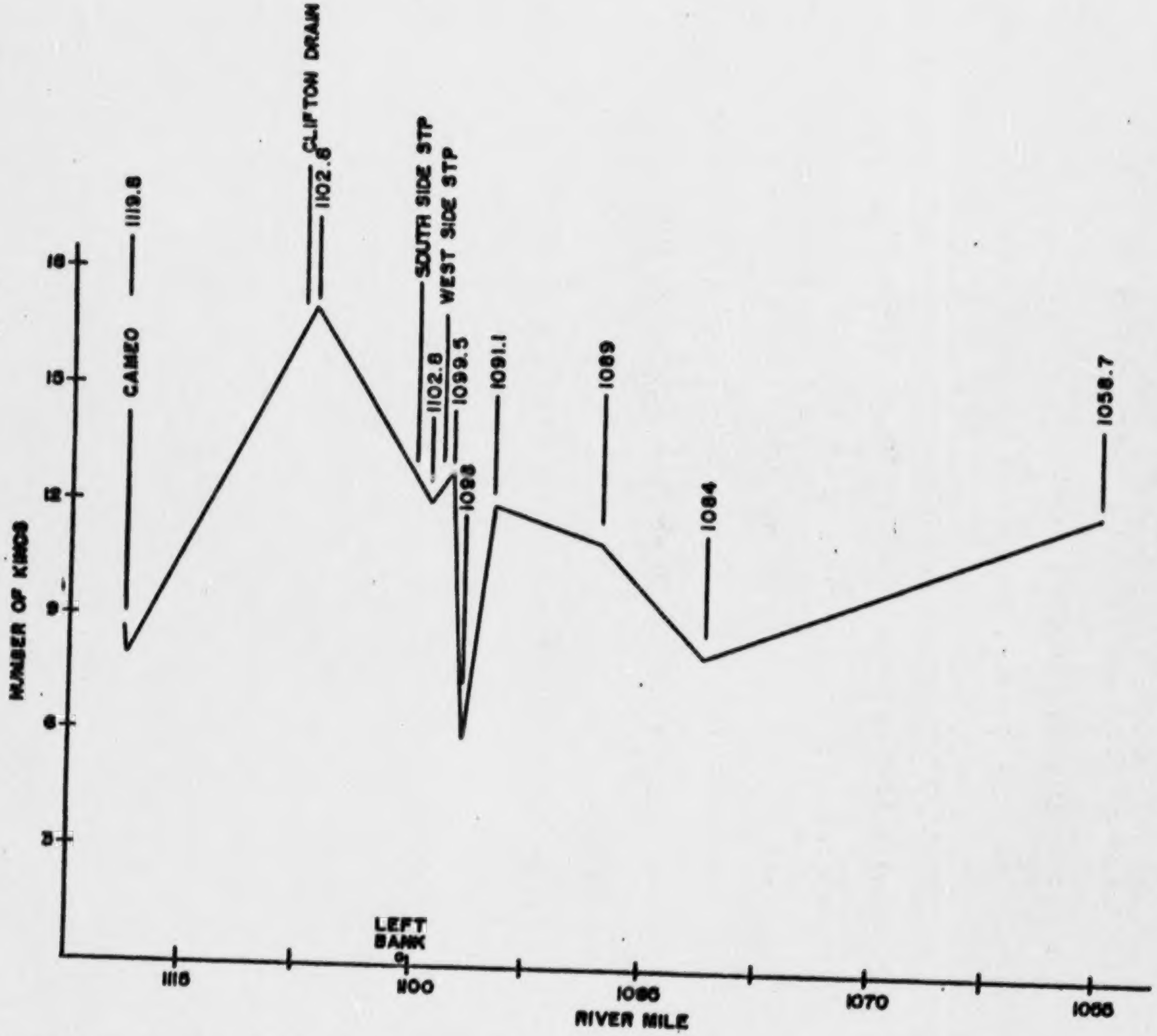


FIGURE 9. COLORADO, NUMBER OF KINDS OF BOTTOM ORGANISMS, JULY - AUGUST 1966

received the wastes from the South Side treatment plant and the Climax Uranium Mill. Here the bottom organisms decreased to 154 per square foot and six kinds, indicating the adverse effects of the waste loads. One mile downstream at Station C-9A, just upstream from the West Side sewage treatment plant outfall, this adverse effect can be observed in the main channel of the Colorado River.

Wastes from the West Side sewage treatment plant completely eliminated aquatic animals from the left bank of the Colorado River for one mile and stimulated growths of sewage fungus (Sphaerotilus natans) on the stream bed. Oil had been discharged to the city sewers and subsequently into the West Side treatment plant. A large portion of the oil entered the trickling filter, killing the biological growths on the filter media and filling the interstices with oily sludge. Most of the oil was washed off the filter into the outfall and to the Colorado River. An oil slick covered the river for one mile and the rocks in the stream bed were oiled.

Effects of the wastes from the West Side sewage treatment plant, indicated by high numbers of pollution-tolerant sludgeworms, were still evident in the benthic population two miles downstream, at Station C-10, and seven miles downstream at Fruita, Colorado. Complete biological recovery was observed at Loma, Colorado, 18 miles farther downstream.

The aquatic life was not affected adversely by American Gilsonite Plant wastes at Loma, Colorado. The Colorado River downstream from Westwater, Utah flows through a fine sediment strata that changes the river bed from one of rock riffles to one of shifting sand. This change in stream bed type eliminates suitable habitat for bottom dwelling organisms, thus reducing the population to 16 per square foot, with a diversity of only three at Moab, Utah.

Algal populations grown on glass slides placed in the Colorado River for a 10-day period increased from 5,000 per square inch at Cameo, Colorado (C-7) to 285,000 per square inch at Clifton, Colorado (C-8). The algal population continued to increase downstream from the Grand Junction, Colorado sewage treatment plants. A maximum of 1,746,600 algae per square inch was recorded downstream from Grand Junction's South Side sewage treatment plant. In the stream reach from Loma, Colorado (C-13) to Moab, Utah (C-17), the attached algal counts ranged from 106,600 to 726,000 per square inch. Algal growths such as these indicate that large quantities of nutrients are being discharged to the Colorado River. The quantity of algae present in the Colorado River from Clifton, Colorado to Moab, Utah could be expected to produce minor fluctuations in the dissolved oxygen concentration. One of the most significant growths of 15,000 Vorticella sp. per square inch was found at Moab, Utah indicating the presence of large numbers of bacteria.

In summary, wastes discharged from Grand Junction's West Side and South Side sewage treatment plants, and the Climax Uranium Mill in Grand Junction, Colorado, affected adversely the aquatic life inhabiting the Colorado River, reducing the population of bottom organisms. Toxic wastes, mainly oil, discharged from the West Side sewage treatment plant eliminated all bottom organisms in a one-mile reach of the Colorado, and adversely affected the population for at least an additional seven miles (Figure 39). This loss of bottom organisms not only reduced the fish food supply, but also indicated environmental conditions that are probably unsatisfactory for fish. The increase in the number of algae attaching themselves to submerged glass slides in the Colorado River downstream of Clifton, Colorado indicates that large quantities of algal nutrients were discharged to the Colorado River. The growth of a large population of protozoa at Moab, Utah indicates the presence of large numbers of bacteria.

SLATE RIVER, COLORADO

Upstream from Crested Butte, Colorado, the Slate River was a clean-water stream. Stoneflies, caddisflies and mayflies predominated the 14 kinds and 184 bottom organisms per square foot observed on October 7, 1966. The Standard Metals Corporation mill, located near Crested Butte on the Slate River, was not discharging at the time of the survey. The Slate River, downstream from Coal Creek (Station SR-4), also supported a population of bottom organisms indicative of unpolluted conditions.

Drainage to Coal Creek from the American Smelting and Refining Company Keystone Mill decreased the bottom organisms population from 56 per square foot with a diversity of 12 upstream to two per square foot of only a single species downstream from the mill operation. Pollution-sensitive organisms that provide food for trout were eliminated from Coal Creek, indicating conditions unfavorable for the propagation of fish. Two miles downstream from the Keystone Mill, Coal Creek began to recover biologically.

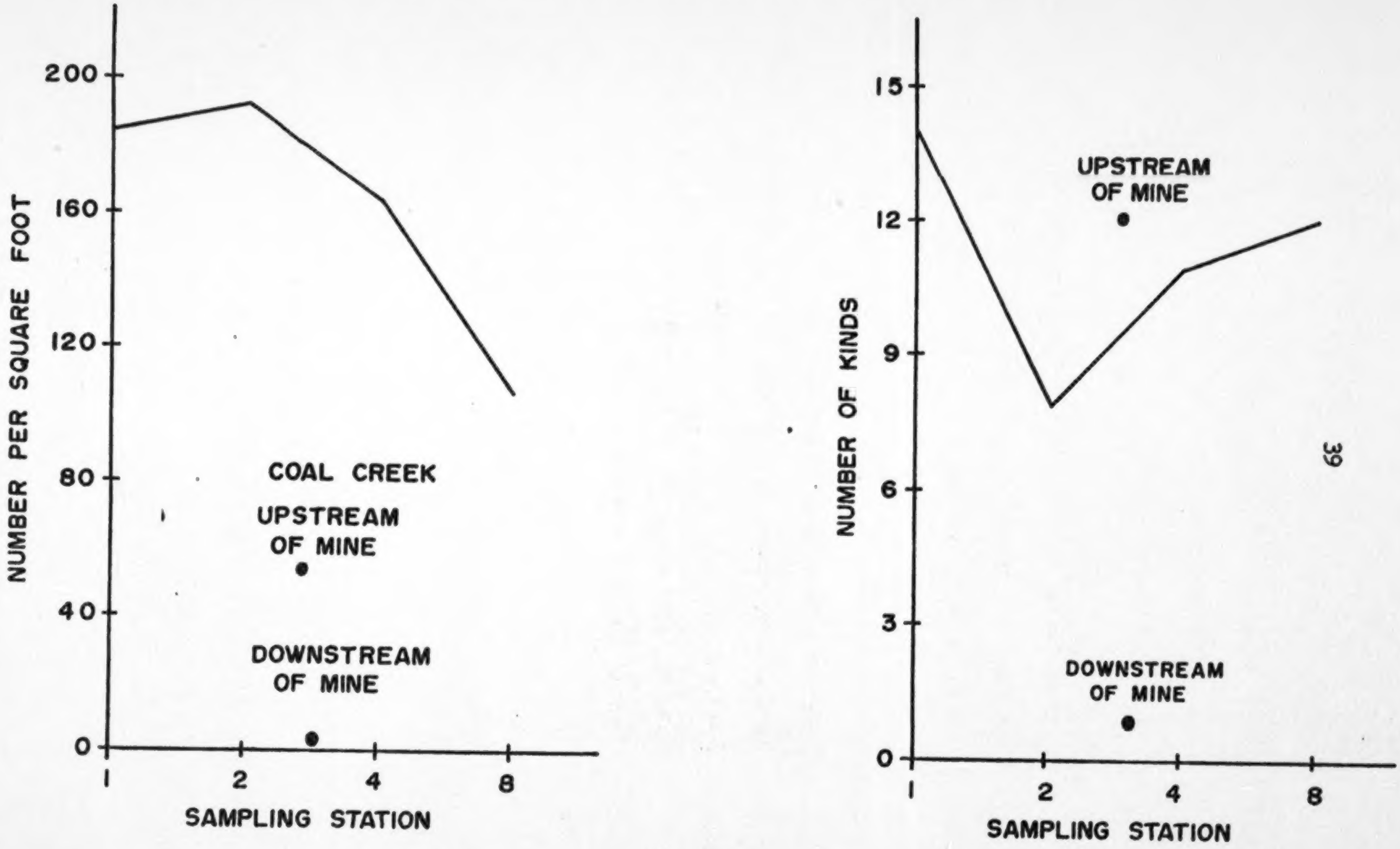


FIGURE 10. SLATE RIVER, NUMBER OF KINDS AND NUMBER PER SQUARE FOOT OF BOTTOM ORGANISMS, OCTOBER 1966.

GUNNISON RIVER, COLORADO

The Gunnison River, near Gunnison, Colorado, downstream to the backwaters of Blue Mesa Dam, a distance of 13 miles, receives intense fishing pressure and is said to support some of the finest trout fishing in the United States.

In the five-day period, July 29 to August 2, 1966, the wastes from the Gunnison sewage treatment plant had no detrimental effect on the river's aquatic life (Figures 12 and 13). Should the waste load increase, or the river flow decrease, the more desirable fish food organisms, such as stoneflies and mayflies, may be replaced by more pollution-tolerant organisms, such as midges and sludgeworms. This, then, would effectively reduce the trout population.

Seventy miles downstream from the backwaters of Blue Mesa Dam the North Fork of the Gunnison River joins the Gunnison near Lazear, Colorado. At Paonia, Colorado the North Fork had insufficient flow to provide a trout fishery, but it could supply fish food to the Gunnison by organism drift. Upstream from Paonia, Colorado the population of bottom organisms numbered 820 per square foot with a diversity of 15 kinds, and was comprised of pollution-sensitive organisms, such as stoneflies, mayflies and caddisflies, which are indicative of unpolluted water (Table 12, Figures 14 and 15). Downstream from Paonia's raw sewage discharge (Station NFG-7), most of the pollution-sensitive organisms, such as stoneflies, mayflies and caddisflies, were replaced by pollution-tolerant sludgeworms. The benthic population was reduced to 137 organisms per square foot with a diversity of only four kinds. Stream recovery was noted 3-1/2 miles downstream. Irrigation return flows in this reach raised the water temperature and turbidity, making the remaining habitat of the North Fork unsuitable for trout (Table 13). Only three sculpins, seven dace and one fathead minnow were captured in a 100-ft. reach of the North Fork just upstream from its confluence with the Gunnison.

Upstream from Hotchkiss, Colorado (Station NFG-8), bottom organisms numbered 1,296 per square foot with a diversity of 11 (Table 10). As a result of municipal waste discharge from Hotchkiss, the benthic population increased to 6,288 per square foot and decreased to six kinds, indicating a degraded water quality. Biological recovery was noted five miles downstream at Station NFG-9. Here the population comprised 206 organisms per square foot with a diversity of 12.

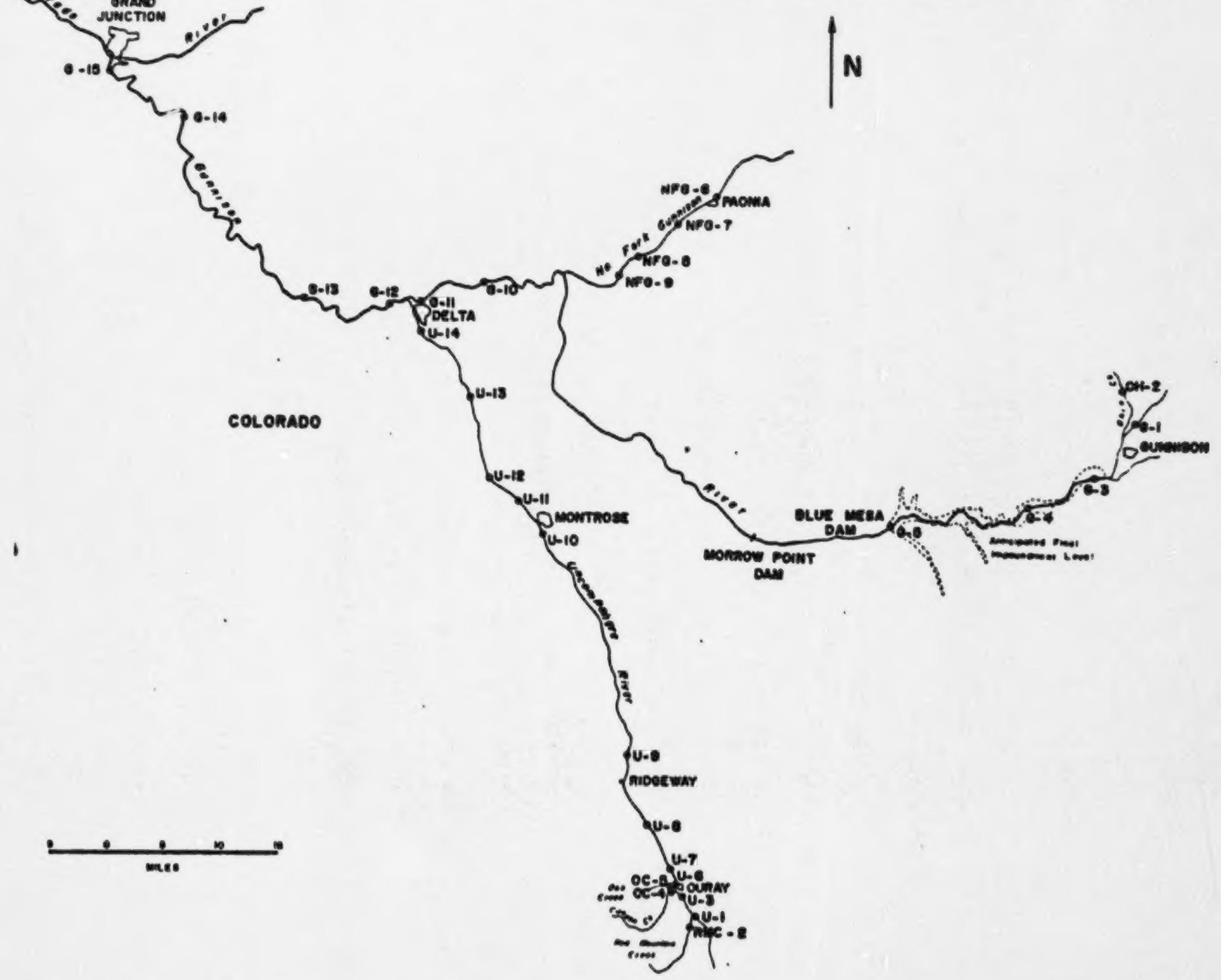
The Gunnison River, downstream from the mouth of the North Fork to the mouth of the Uncompahgre River at Delta, Colorado, supported a diverse and abundant population of bottom organisms indicating an enriched, but unpolluted, stream.

The population of bottom organisms in the Gunnison River, downstream from the confluence of the Uncompahgre River (G-12), was degraded in both numbers and kinds as a result of wastes from the Skyline Food Corporation at Delta and irrigation return flows entering the Uncompahgre River.

During the October 1966 survey waste discharges from the Holly Sugar Company at Delta, Colorado to the Gunnison River decreased the population of bottom organisms from 11 to eight kinds and the number of

FIGURE 11.

STUDY AREA
GUNNISON RIVER SYSTEM SURVEY



N
Colorado River
GRAND JUNCTION
G-15
G-14
Gunnison
G-13
G-12
G-11
DELTA
U-14
G-10
NFG-9
NFG-8
NFG-7
NFG-6
PAONIA
No. Fork Gunnison
COLORADO
U-13
U-12
U-11
MONTROSE
U-10
Uncompahgre
River
U-9
RIDGEWAY
U-8
U-7
U-6
OC-5
OC-4
OURAY
U-3
U-1
RMC - 2
Oak Creek
Canyon Cr.
Red Mountain Creek
River
MORROW POINT DAM
BLUE MESA DAM
G-5
G-4
G-3
Anticipated Final Impoundment Level
GUNNISON
PG-1
OH-2
0
5
10
15
MILES

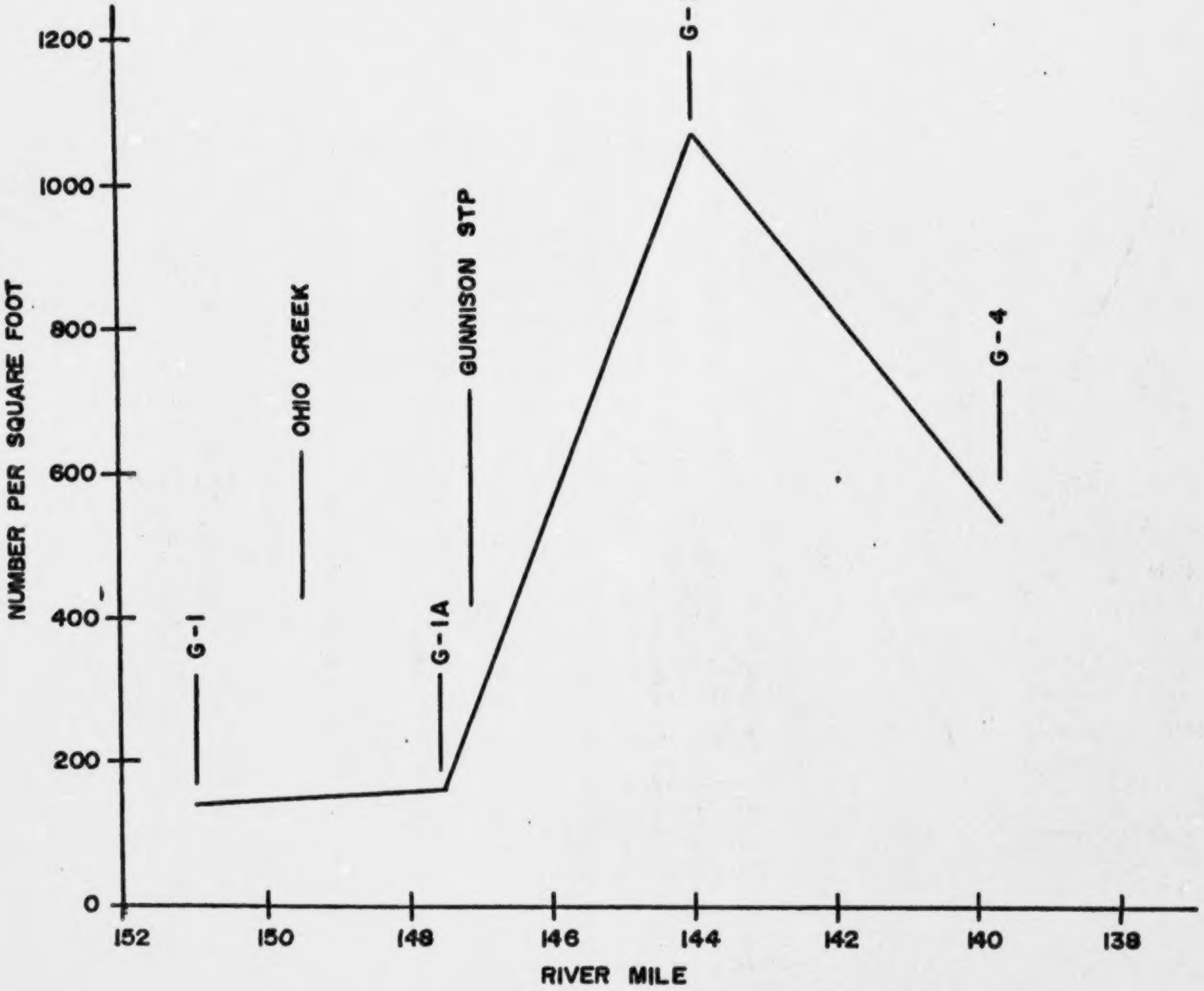


FIGURE 12. GUNNISON RIVER, NUMBER OF BOTTOM ORGANISMS PER SQUARE FOOT, JULY 1966

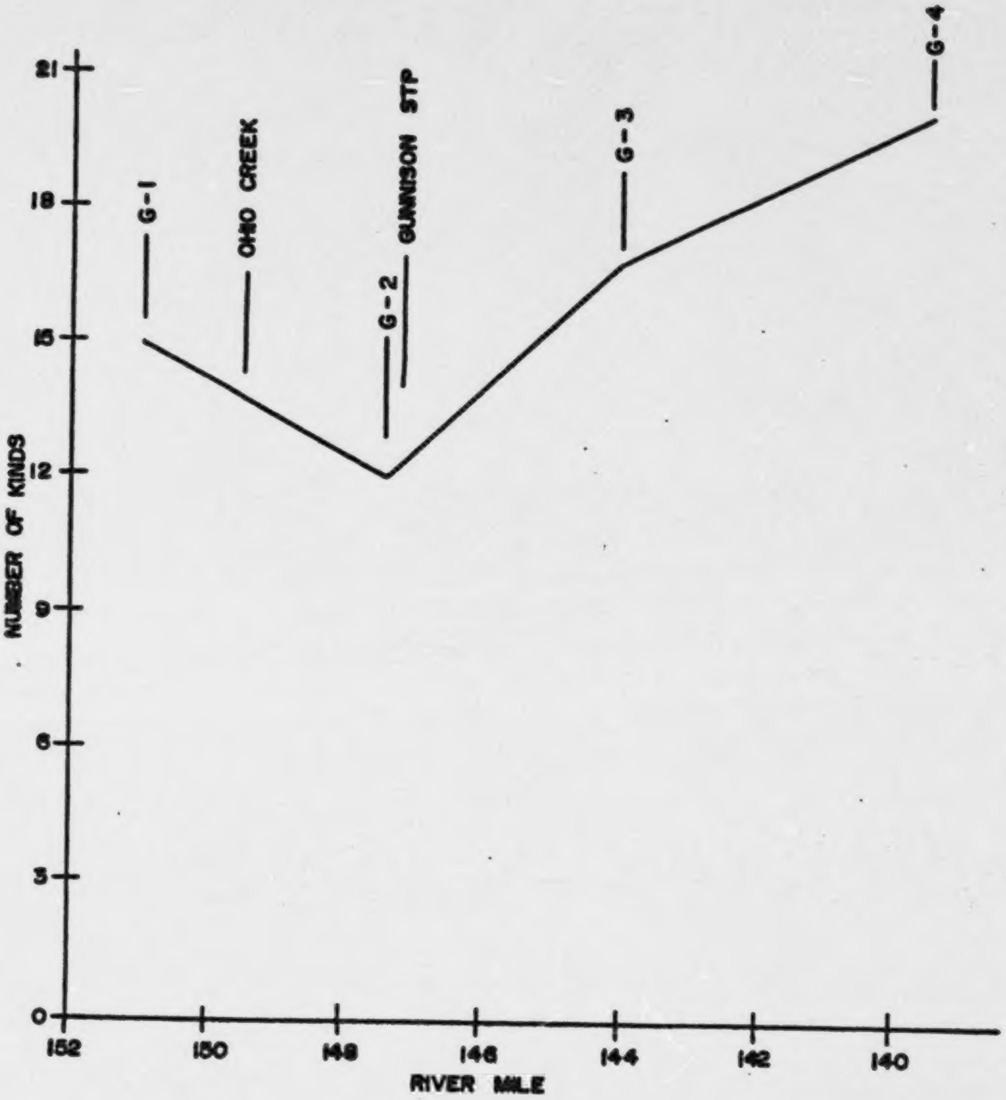


FIGURE 13. GUNNISON RIVER, NUMBER OF KINDS OF BOTTOM ORGANISMS, JULY 1966.

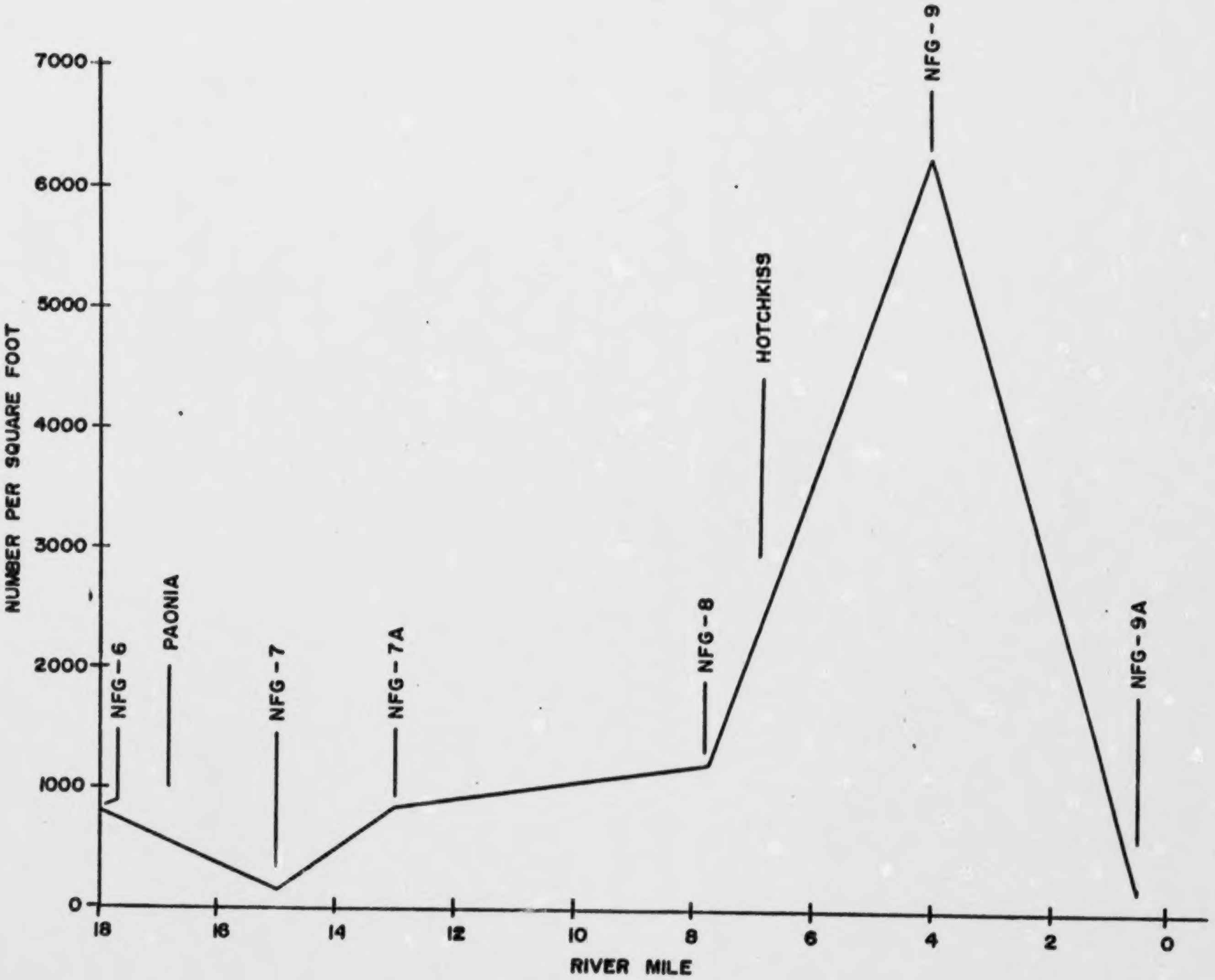


FIGURE 14. NORTH FORK GUNNISON, NUMBER OF BOTTOM ORGANISMS PER SQUARE FOOT, JULY-AUGUST 1966.

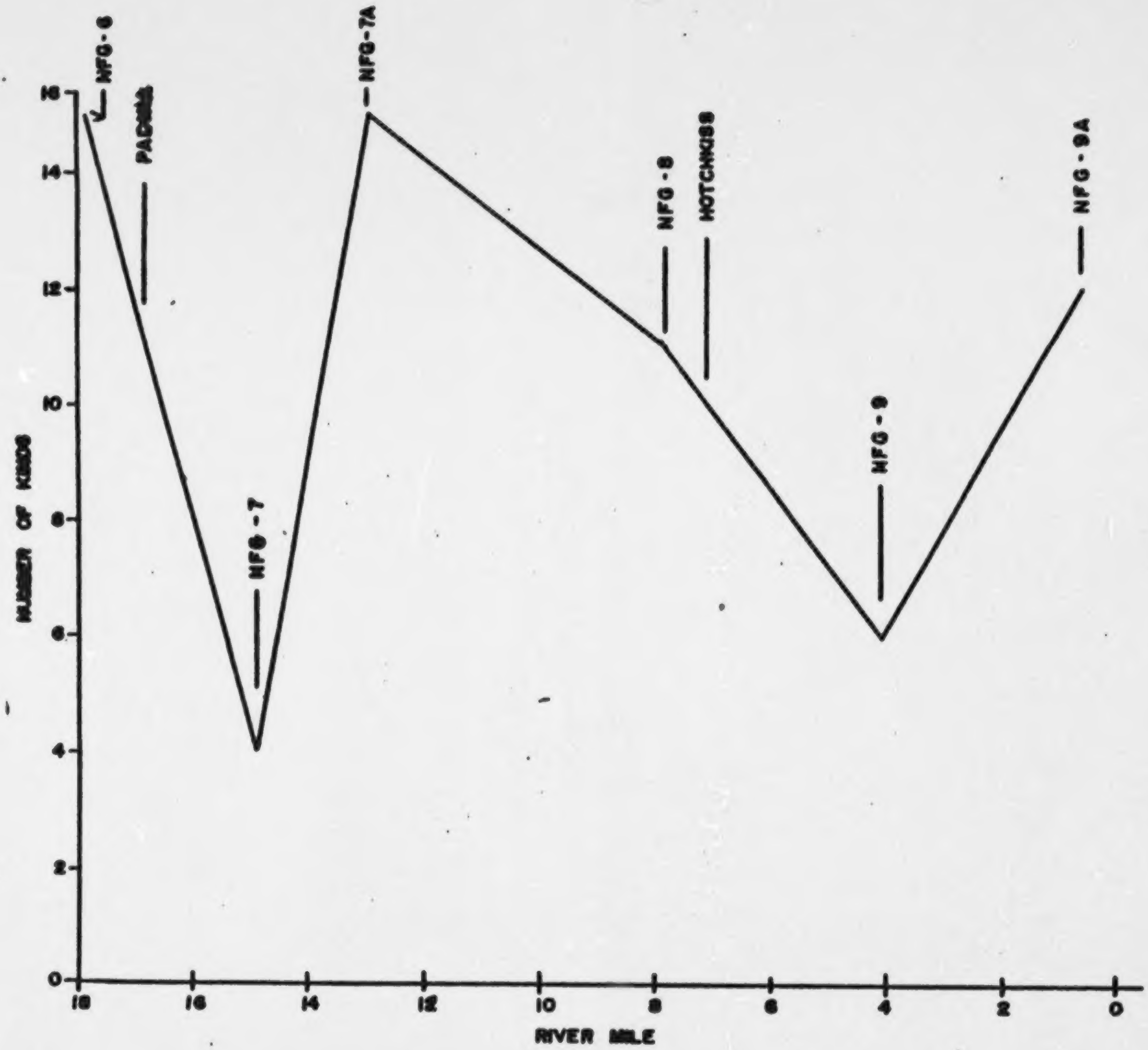


FIGURE 15. NORTH FORK GUNNISON, NUMBER OF KINDS OF BOTTOM ORGANISMS, JULY-AUGUST 1966.

organisms from 814 to 84 per square foot at a station about 200 yards downstream from the discharge. The deleterious effect of the Holly Sugar Company discharge was reduced somewhat by the additional dilution provided by the Uncompahgre River about one-half mile downstream. Three and one-half miles downstream from the mouth of the Uncompahgre River, the population of bottom organisms in the Gunnison River indicated that the water quality of the Uncompahgre River was slightly better than that of the Gunnison River downstream from the Holly Sugar Company.

Twenty-seven miles downstream the bottom organism population had recovered from the adverse effects of the Holly Sugar Company wastes. During the July-August and October surveys, the population of bottom organisms in the Gunnison River at Grand Junction, Colorado, just upstream from its confluence with the Colorado River, was predominantly clean-water organisms, such as stoneflies, mayflies and caddisflies. As evidenced by the above, the Gunnison River did not have a pollutional effect on the Colorado River during the surveys.

In summary, the discharge of raw sewage by the municipality of Paonia, Colorado degraded 3-1/2 miles of the North Fork of the Gunnison River, eliminated all of the pollution-sensitive organisms and provided food for pollution-tolerant sludgeworms. Irrigation return flows increased the water temperature and turbidity of the North Fork and thereby created environmental conditions unfavorable for trout. The discharge of municipal wastes from Hotchkiss, Colorado degraded the aquatic environment, reduced the number of kinds of bottom organisms and

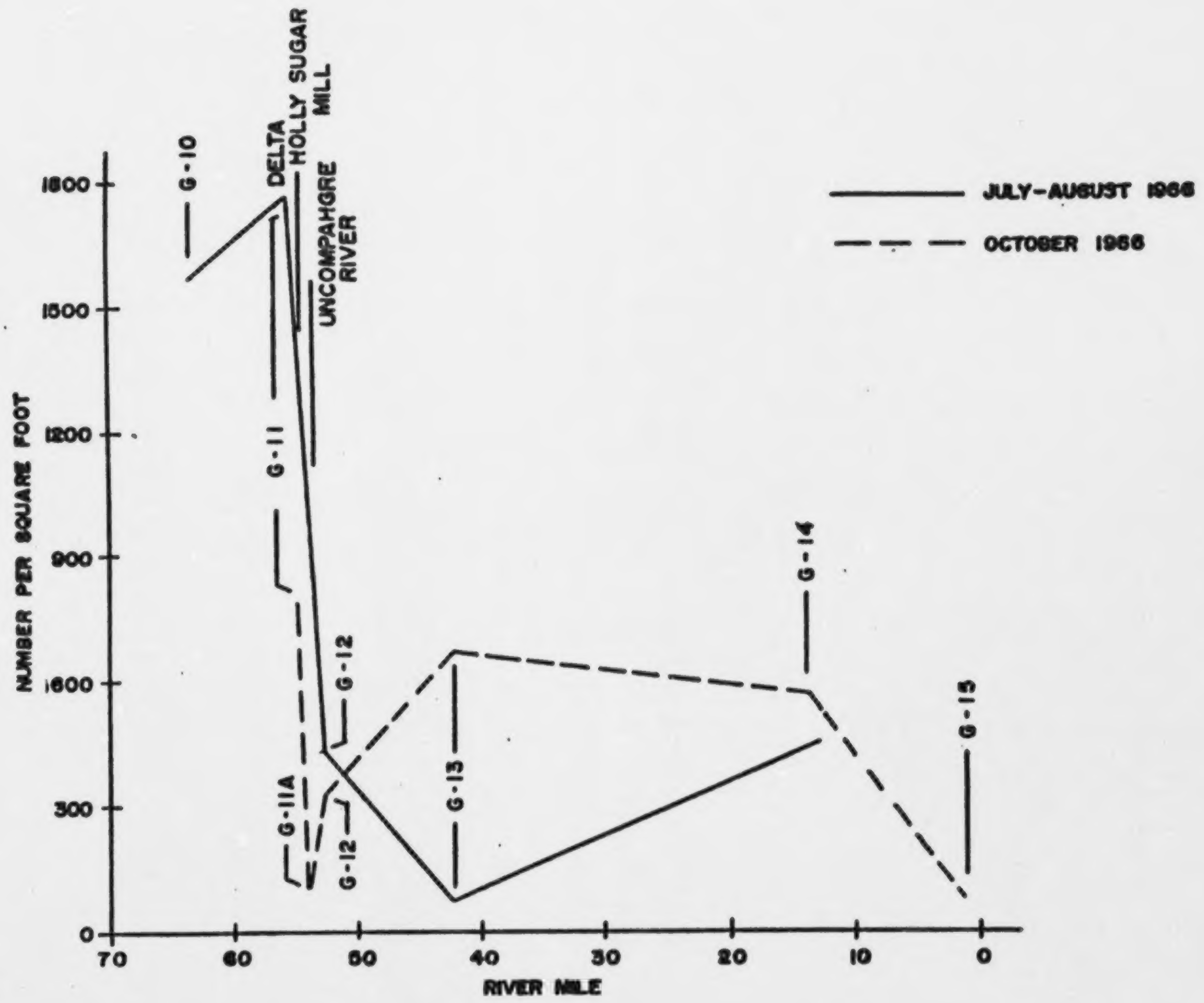


FIGURE 16. GUNNISON RIVER, DELTA-GRAND JUNCTION NUMBER OF BOTTOM ORGANISMS PER SQUARE FOOT.

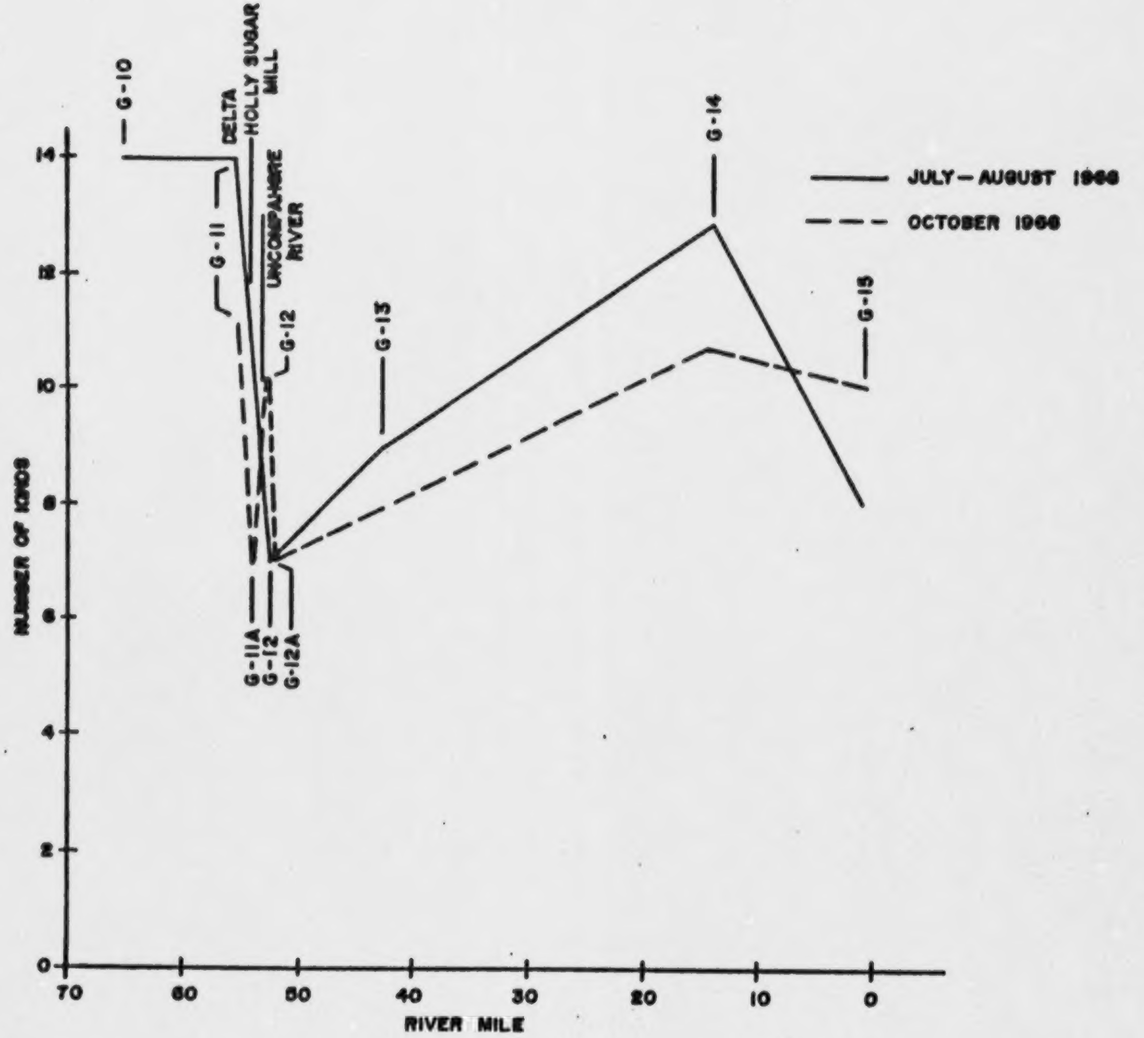


FIGURE 17. GUNNISON RIVER, DELTA-GRAND JUNCTION, NUMBER OF KINDS OF BOTTOM ORGANISMS

provided food for the remaining tolerant organisms. Wastes from the Holly Sugar Company suppressed the population of all bottom organisms immediately downstream by adding silt and sludge. These wastes eliminated pollution-sensitive organisms and increased the pollution-tolerant organisms in at least 10 miles of the Gunnison River (Figure 39). Even were the Holly Sugar Company not discharging, wastes from the Skyline cannery degraded the Uncompahgre River sufficiently to adversely affect the population of bottom organisms in the Gunnison River. The Gunnison River recovered, however, before it reaches the Colorado River.

CIMARRON RIVER, COLORADO

The Cimarron and Little Cimarron Rivers, upstream from the gravel washing operation located on Highway 50 near Cimarron, Colorado, supported a diverse, abundant benthic population typical of an unpolluted stream. The Cimarron River supported 13 kinds of organisms at a density of 1,380 per square foot; the Little Cimarron supported 11 kinds at a density of 840 per square foot (Table 15). A population of aquatic invertebrates of this magnitude would support a large population of trout and other fish. The total suspended solids (TSS) at these stations were quite low, 17 mg/l at Station 1, and 3 mg/l at Station 2. The Cimarron River had been diverted around the gravel digging area, and wastes from the gravel washing operation were discharged to ponds constructed for that purpose. These ponds were retained by 5-foot-thick gravel dikes that filtered the wash water before it discharged to the river. The TSS increased to 118 mg/l downstream from the gravel washing operation at Station 3, due largely to the resuspension of silts deposited before the ponds were constructed. As a result of the silt resuspension and some loss of silt through the pond dikes, 11,664 pounds per day of TSS were present in the Cimarron River water flowing by this point.

The relative effectiveness of these ponds can be determined by comparing the TSS measurements at stations immediately downstream from Dolores River gravel operations, where no treatment was present, to stations on the Cimarron River. The gravel borrow pit on the Dolores River, located near Rico, Colorado, is discussed later in this report. Immediately downstream from this operation on the Dolores River, a TSS concentration of 312 mg/l was observed, as compared to the Cimarron River's concentration of 118 mg/l. Even with the reduced silt concentration entering the Cimarron River, the bottom organism density decreased 85 percent from that observed at Station 1 (Figure 18). The observed population of 214 organisms per square foot nevertheless provides a partial fish food supply. Some of the more desirable aquatic invertebrates, such as stonefly nymphs and beetle larvae, were present in small numbers. Trout and other fish might encounter some difficulty in capturing the invertebrates and fishermen's lures because of decreased light penetration. The silt discharged to the Cimarron River decreased the density of bottom organisms by reducing their food supply, mainly algae and bacteria. The increased TSS from 118 mg/l at Station 3 to 169 mg/l at Station 4 was due to higher flows resuspending previously deposited silt. This increase in TSS between the two stations represents a resuspension of 7,160 pounds of solids per day, bottom organisms exhibited a slight recovery in numbers (214 to 238 per square foot), and full recovery of diversity at Station 4.

The trout fishery of the Cimarron River suffered not only a reduced food supply, but also the loss of spawning beds where silt covered the gravel stream bottom. Trout eggs require well

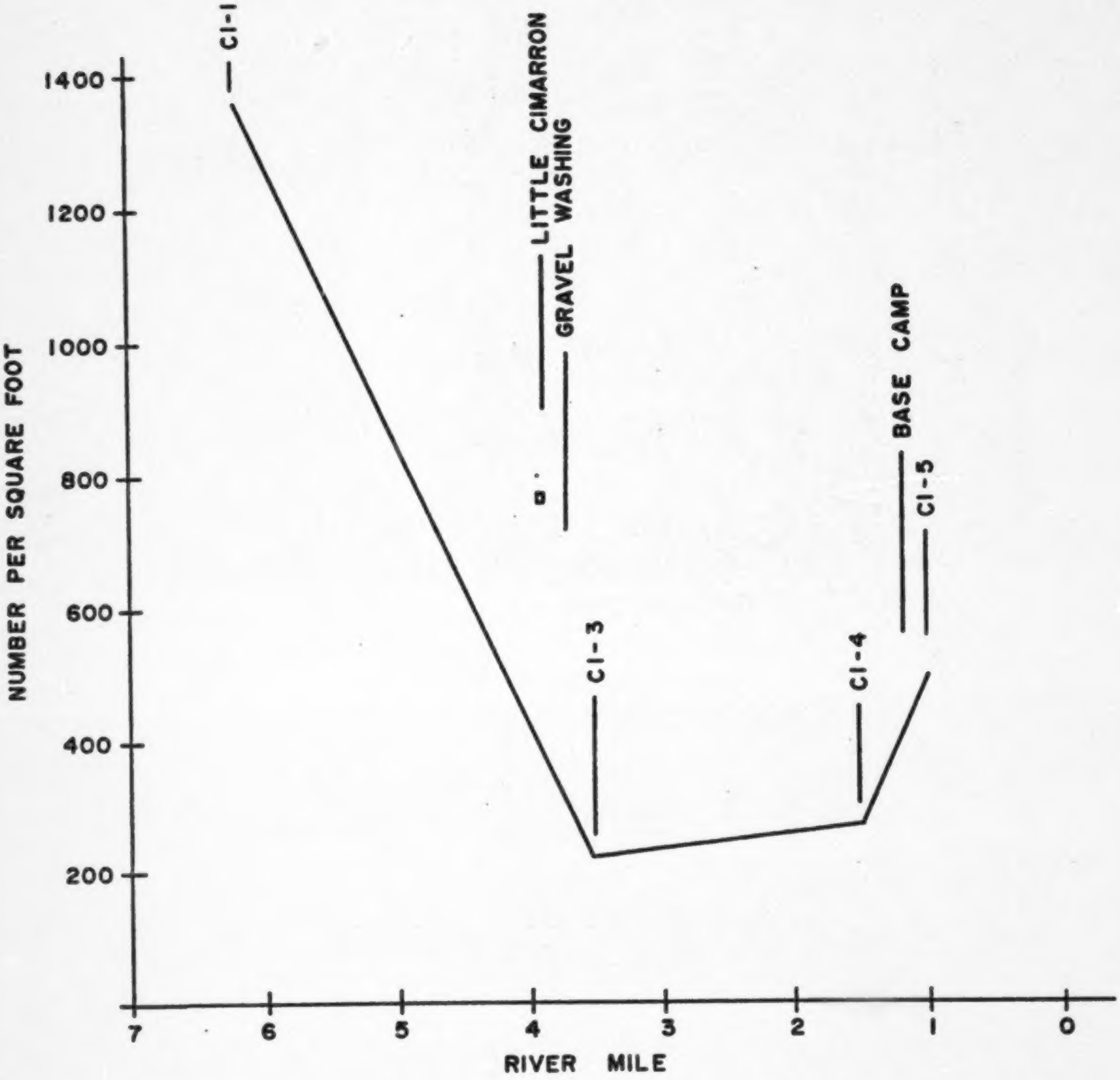


FIGURE 18. CIMARRON RIVER, BOTTOM FAUNA DATA, NUMBER OF ORGANISMS PER SQUARE FOOT, OCTOBER, 1966.

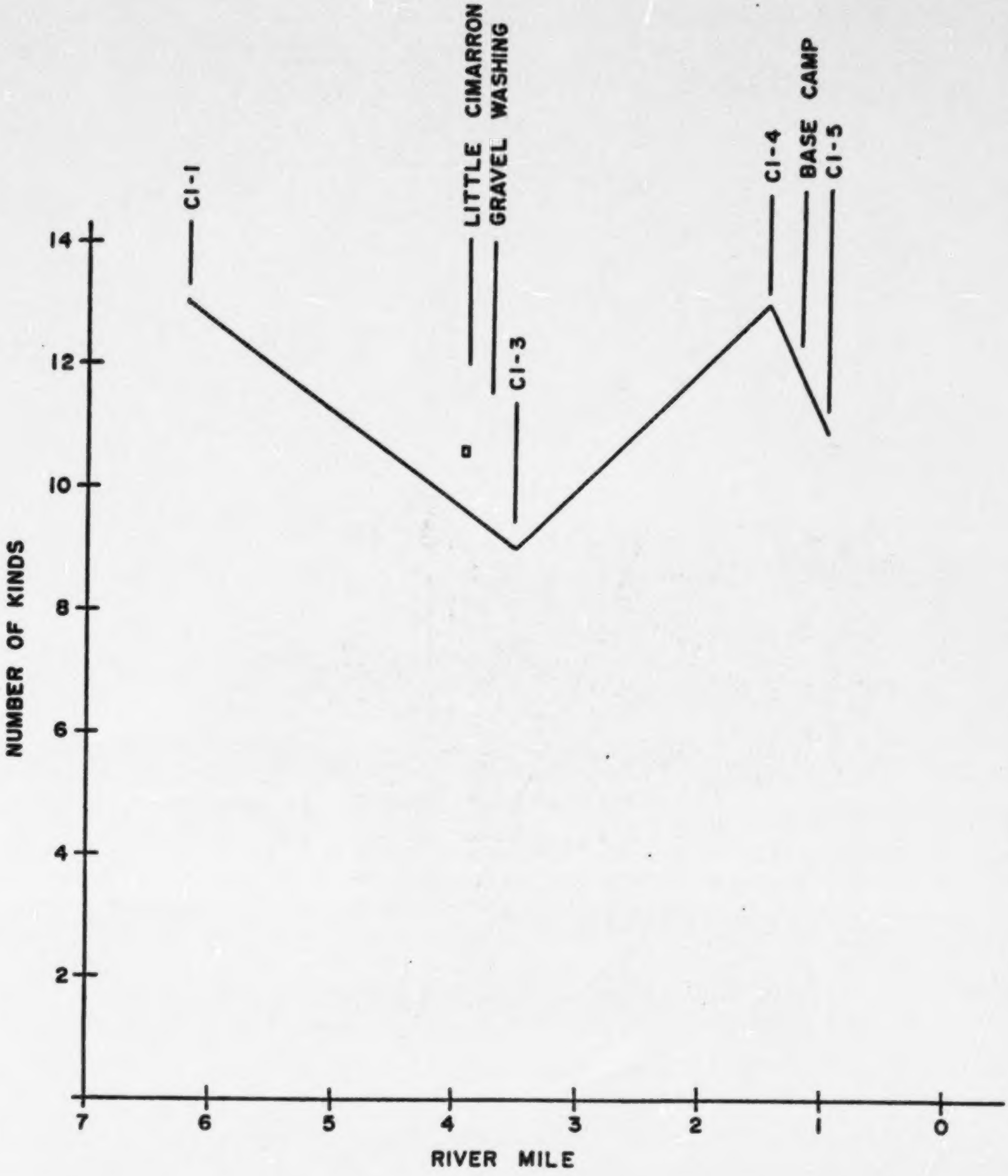


FIGURE 19. CIMARRON RIVER, BOTTOM FAUNA DATA, NUMBER OF KINDS, OCTOBER, 1966.

oxygenated water passing over their upper surfaces, as well as water passing up through the gravel to supply oxygen to the lower surfaces of the eggs.

In summary, silt resulting from the gravel washing operation on the Cimarron River at Highway 50 degraded the aquatic life in the stream (Figure 39). A portion of the silt resulting from the washing of gravel was removed by settling ponds and by diversion of the river around the gravel mining area. Silt deposits resulting from operations preceding the pond construction were resuspended by higher flows. Spring floods usually flush out these deposits. Aquatic life was degraded by silt as shown by a reduction in bottom organisms with a resultant loss of fish food and by the covering over of gravel fish-spawning beds. The population of bottom organisms downstream from the gravel washing operation should increase in density when the silt deposits are flushed out during the spring runoff and if the holding ponds contimue to operate effectively.

Until the silt deposits disperse, it will be difficult to predict when or if the bottom organism population will recover to the level observed upstream. The ponds appeared to be removing a major portion of the silt at the time of the survey. A follow-up study should be conducted to determine whether the aquatic life has recovered.

UNCOMPAHGRE RIVER AND RED MOUNTAIN CREEK, COLORADO

The Uncompahgre River (Figure 11) rises in the San Juan Mountains and flows 10 miles northwest before crossing Highway 550, south of Ouray, Colorado. Seven-mile-long Red Mountain Creek enters the Uncompahgre 0.2 mile downstream from the Highway 550 crossing. Oak and Canyon Creeks enter the Uncompahgre 2 1/2 miles farther downstream. The next major hydrological change occurs 35 miles downstream near Montrose, Colorado, when the Uncompahgre River receives water diverted from the Gunnison River. Two diversions (at Montrose and Olathe, respectively) have removed nearly all the water from the Uncompahgre for irrigation. At Delta, Colorado, the Uncompahgre is made up of irrigation return flows.

Above Highway 550 (U-1) the Uncompahgre River provides trout fishing, although this uppermost reach of the river flows through terrain so rugged that it limits access to fishermen.

The population of bottom organisms in the Uncompahgre River at Station U-1 was comprised of 6 kinds of organisms totaling 68 individuals per square foot. Four of the species, representing 92 percent of the population, were pollution-sensitive types, such as mayflies and stoneflies (Table 17). These were collected from an environment with a minimum pH of 6.8 (average pH 7.1), maximum concentrations of 0.4 mg/l of total iron, 0.16 mg/l of zinc, and less than 0.02 mg/l of copper. The alkalinity of 30 mg/l lowers the toxicity of these metals as compared to lower alkaline waters.

Measurements showed zero acidity in this reach. The Uncompahgre River, upstream from Red Mountain Creek, was an unpolluted stream as indicated by the population of bottom organisms.

Red Mountain Creek originates where its East and West Forks join. The West Fork of Red Mountain Creek contained a population of bottom organisms typical of a clean-water stream. Eight kinds were present, including 6 clean-water types, such as stoneflies, mayflies, and caddisflies with a total population of 84 organisms per square foot. Rock substrates were free from iron floc deposits permitting the development of algal and bacterial communities that supplied food for the bottom organisms. In this reach, algal growths on artificial substrates numbered 200,000 cells per square inch, predominantly clean-water associated diatoms. The small flow (0.5 cfs) in the West Fork limits the development of a trout fishery. The pH of the West Fork was 5.8 and the total iron concentration was 0.33 mg/l, which constitutes acceptable water quality for the aquatic biota.

The East Fork of Red Mountain Creek, like the West Fork, had a small flow (0.5 cfs). It supported pollution-sensitive stoneflies, mayflies, and caddisflies, but had inadequate flow to support a trout fishery. Acid drainage from an abandoned mine in the town of Red Mountain had completely destroyed all aquatic life in the East Fork. A number of detrimental conditions, such as suffocation by iron precipitates, low pH (3.1) and toxic iron concentrations (86 mg/l), contributed to this destruction.

Drainage from the Genessee and the Idarado mines entered Red Mountain Creek just downstream from the confluence of the East and West Forks. No bottom organisms were present in Red Mountain Creek downstream from these mine drainages. No algae were present on the rocks, or on microscope slides placed in the stream for a 10-day period; 400,000 algal cells per square inch grew on the microscope slides placed upstream from these discharges, and pollution-sensitive stoneflies, mayflies, and caddisflies were found living in the stream.

The magnitude of the precipitating iron can be assessed by comparing the amount of iron precipitated on glass slides during uniform time periods. In the relatively unpolluted West Fork of Red Mountain Creek, 33 mg per square inch of iron were precipitated on microscope slides in 10 days; and diverse populations of bottom organisms and algae were found. Just upstream from the mouth of Red Mountain Creek, 41,040 mg per square inch of iron were precipitated in 10 days. No aquatic life was observed on, in, or under this heavy iron floc. In addition to this large quantity of iron precipitated on the stream bed, Red Mountain Creek discharged 1,307* pounds per day of total iron to the

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* This value is slightly less than the difference between U-1 and U-3 because there are some seeps between the confluence of Red Mountain Creek and U-3.

Uncompahgre River. Concentrations of other metals and the total acidity of Red Mountain Creek at RMC-2 were also at levels toxic to fish and bottom organisms. With the buffering effect of the carbonates removed, the 3.12 mg/l of zinc and 0.68 mg/l of copper were extremely toxic to aquatic life.

Downstream from the confluence of Red Mountain Creek, all aquatic organisms and fish (Figures 20 and 21) were eliminated from the Uncompahgre River by the combined adverse concentrations of acid and metals, as here summarized:

	Upstream from Red Mountain Creek (U-1)		Downstream from Red Mountain Creek Confluence (U-	
	Maximum Concen. mg/l	Pounds/Day Calculated on Avg. Concen.	Maximum Concen. mg/l	Pounds/Day Calculated on Avg. Concen.
Total Iron	0.4	6.00	6.40	1399
Aluminum	0.5	16.70	7.80	1476
Zinc	0.16	5.00	0.96	205
Copper	< 0.02	< .67	0.30	64
Alkalinity	30.00		20.00	
Acidity	0.00		55.90	
pH (minimum)	6.8 units		4.90	
Flow	6.2 cfs		48 cfs	

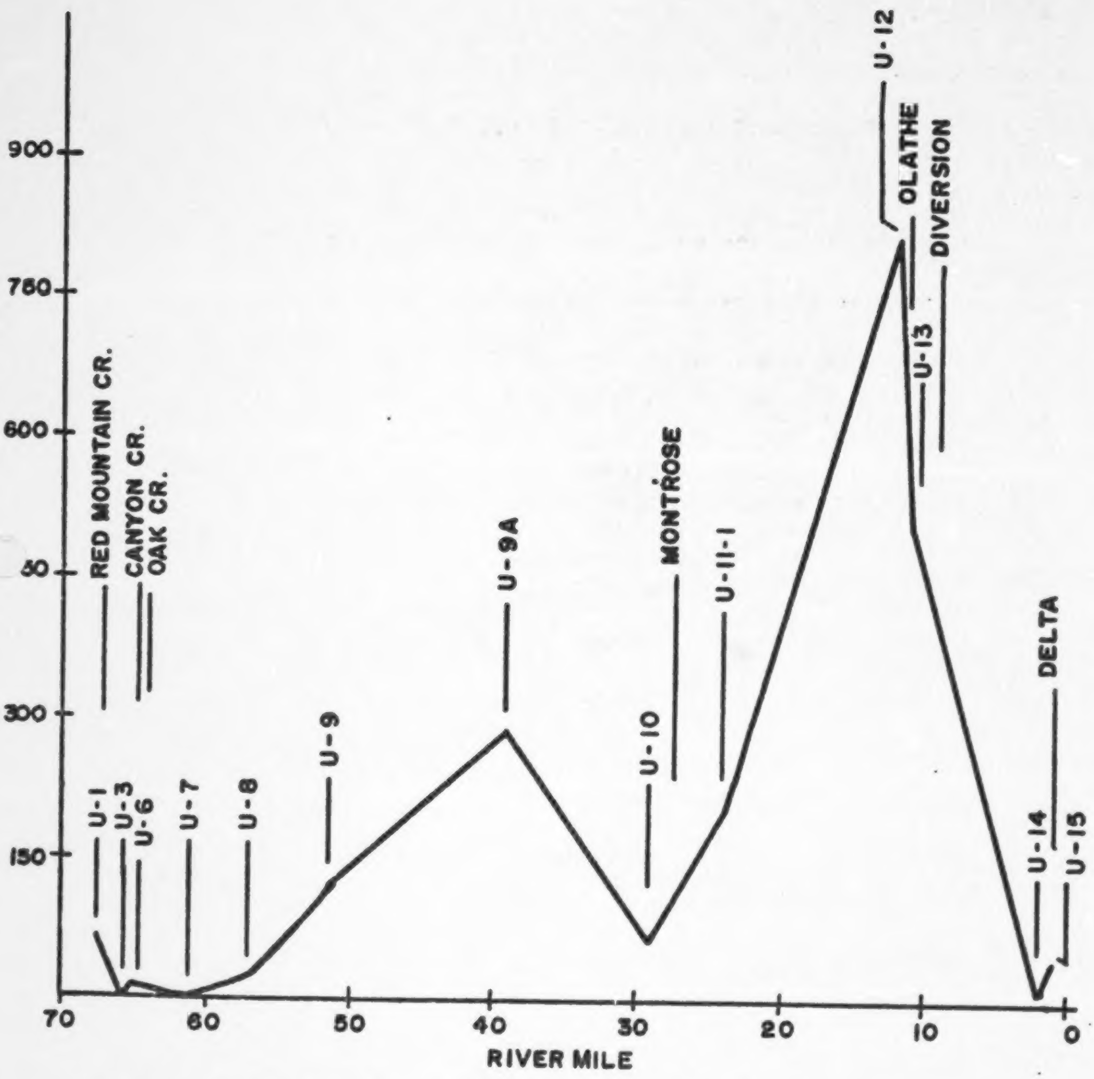

FIGURE 20. Uncompahgre River, Number of Bottom Organisms Per Square Foot, July-August 1966.

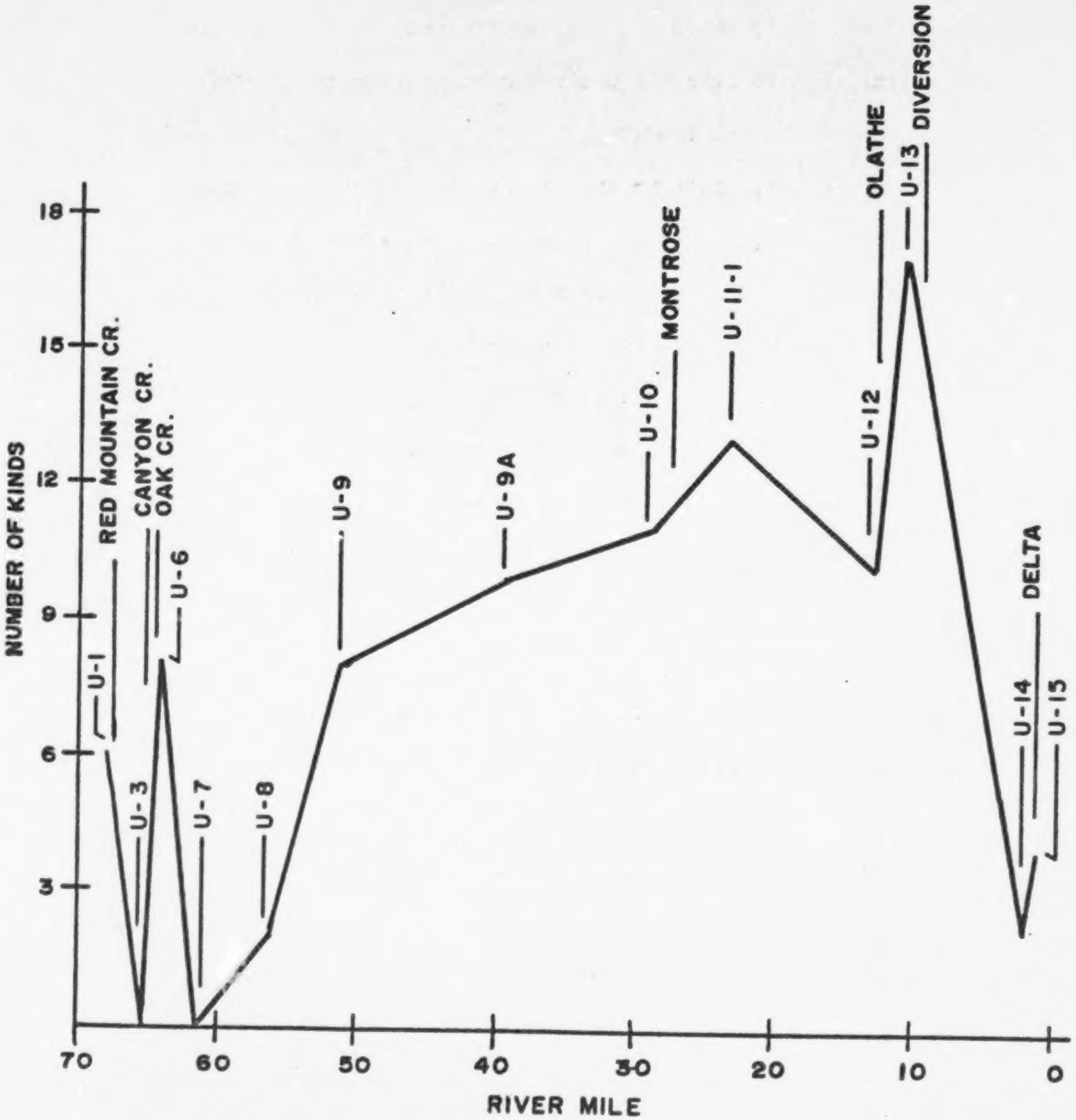

FIGURE 21. Uncompahgre River, Number of Kinds of Bottom Organisms, July- August 1966.

Precipitation of approximately half the stream loads of iron, aluminum, copper, and zinc plus neutralization of 80 percent of the acid in the 1.8-mile reach of stream between the confluence of Red Mountain Creek and Station U-3 was insufficient to produce conditions suitable for aquatic life. Aquatic organisms were not found for the next 10 miles downstream from U-3.

Canyon Creek, upstream from its mouth in Ouray, Colorado, supported one kind each of mayfly and midge larva at a density of 31 organisms per square foot. Reduced populations in Canyon Creek resulted from sediments discharged to it by Weehawken Creek. The maximum concentration of total suspended solids was 892 mg/l with an average concentration of 203 mg/l for the first 12 days of August, 1966. Silt covered the stream bed suppressing aquatic organisms through suffocation, and destroyed their habitat. These solids would also have had a detrimental effect on the aquatic life of the Uncompahgre River, if any life were present.

Oak Creek has its confluence with the Uncompahgre 100 feet downstream from Canyon Creek. Oak Creek supports a diverse population of bottom organisms typical of a clean-water stream. Seven types of aquatic organisms, of which six are pollution-sensitive forms such as stoneflies, mayflies and caddisflies, were present at a total population density of 88 organisms per square foot.

The Uncompahgre River in Ouray (U-6) yielded no fish during extensive sampling with an electric fish shocker. Examination of rocks in the river indicated that some aquatic organisms drift down from Canyon Creek and more from Oak Creek. These organisms were short-lived in the Uncomaphgre River, however, in that three miles downstream from the respective confluences (Station U-7) no organisms could be found. Oak Creek and Canyon Creek discharged sufficient buffered water to neutralize the residual acid from Red Mountain Creek and raise the pH from an average of 5.6 at U-3 to 6.9 at U-6. The buffering capacity of the Uncompahgre River upstream from Ouray was reduced to less than 10 mg/l of alkalinity by the residual acid from Red Mountain Creek. The pH values at stations sampled downstream from Station U-6 ranged from a minimum of 6.9 at U-7 to a maximum of 8.5 at Station U-14. The reduction in toxic metal concentrations provided by the dilution of Oak and Canyon creeks was insufficient to allow the recovery of aquatic life. Concentrations of 4.89 mg/l of total iron, 6.81 mg/l of aluminum, 0.545 mg/l of zinc, and 0.135 mg/l of copper, singly or collectively, would be toxic to fish and aquatic invertebrates. Loadings of heavy metals reached a maximum in Ouray (U-6) with 1,916 pounds per day of total iron, 2,669 pounds per day of aluminum, 213 pounds per day of zinc, and 53 pounds per day of copper at a flow of 72.8 cfs. (A large portion of the aluminum enters via Canyon Creek.)

Iron precipitates were much less in the Uncompahgre River at Ouray than in Red Mountain Creek. At Ouray (U-6), precipitated iron on submerged glass slides measured 84 mg/square inch compared to 41,040 mg/square inch at RMC-2. The reduced iron precipitation in the Uncompahgre

River was due to increased flow and dilution provided by Canyon and Oak creeks.

No algae were found on microscope slides in the Uncompahgre River at U-6. Either the iron precipitation or the toxic copper prevented algal growth.

Ten miles downstream from Ouray (U-8), the Uncompahgre River began to recover biologically from mine drainage discharged from the Genessee and Idarado mines into Red Mountain Creek. Here, two kinds of mayflies were present at a population density of 24 individuals per square foot. Two and one-half miles downstream (U-9) from Ridgeway, biological recovery of the Uncompahgre River was complete with eight kinds of bottom organisms at a density of 114 per square foot. Five of the eight kinds were the pollution-sensitive mayflies, caddisflies and beetles. Four days of hoopnet fishing provided a catch of 41 sculpins, dace and mountain and fine-scale suckers. Recovery of the aquatic life was also evident by the growth of 342,000 algal cells per square inch on submerged microscope slides during a 10-day period. Iron precipitate on the microscope slides had decreased to near the quantity found at the control station (67.8-7.1) on Red Mountain Creek (45 mg/square inch). Recovery of the aquatic community can be directly related to the precipitation and dilution of toxic materials, and the increase in alkalinity that decreased the toxic effects of copper and zinc.

Populations of bottom organisms continued to increase in both numbers and kinds from Ridgeway downstream to Colona (U-9A) where the population of bottom organisms was comprised of 10 kinds, with a density of 286 organisms per square foot. The increase in total numbers of organisms can be attributed to increased nutrients that provided food for them in the form of algae and bacteria.

Between stations U-9 and U-10 from Colona to Montrose, the Uncompahgre River receives water from the Gunnison tunnel. The population of bottom organisms decreased from 286 to 55 organisms per square foot, while the number of kinds increased from 10 to 11, indicating that the water from the tunnel was less productive and diluted the nutrients in the Uncompahgre.

The fish population did continue to increase from the 41 fish captured at Station U-9 to 116 captured at Station U-10 (Table 18). The trout captured along with other fish in four net-days in the reach upstream from Montrose indicated that the Uncompahgre River had recovered biologically from the upstream mine waste discharged at Ouray, Colorado.

Downstream from Montrose (U-11-1) the population of bottom organisms increased to 13 kinds at a density of 147 individuals per square foot. This increase in productivity was also observed in the algal community where the growths increased from 59,700 at Station U-10 to 652,100 algal cells per square inch of microscope slide at Station U-11. The fish population also increased from 116 to 684 fish in four net-days respectively at each of these stations. Wastes entering the Uncompahgre River from the Montrose area were insufficient to have deleterious effects on the aquatic life, but contained sufficient nutrients to increase the net productivity.

Bottom organism populations, consisting of 10 and 17 kinds with densities of 492 and 491 per square foot respectively, were found at stations U-12 and U-13 near Olathe. These values are indicative of clean waters.

The population of bottom organisms in the Uncompahgre River decreased drastically in the reach from the diversion at Olathe to Delta. The population at U-14 (Delta) was comprised of two kinds of organisms with a density of five per square foot. The populations remained at this low level from Delta downstream to the Uncompahgre's confluence with the Gunnison River. This sparse population can be attributed to the periodic diversion of water which results in the exposure of major portions of the stream bed. It is doubtful that this stream reach could support a trout fishery because of temperature increases and turbidity resulting from the irrigation return flows.

In summary, mine drainage from the Genessee and Idarado mines into Red Mountain Creek produced mineral precipitates that eliminated aquatic life through habitat destruction by blanketing the stream bed. Waters in upstream reaches were also toxic, containing high concentrations of zinc, copper, iron and aluminum.

Downstream from the confluence of Red Mountain Creek and the Uncompahgre River, the aquatic life was eliminated for a distance of 10 miles by acid mine drainage (Figure 39). In addition, sediments from Canyon Creek would have had a detrimental effect on the aquatic life, in any had been present. The above-mentioned pollution is a detriment to the community of Olathe since it precludes the establishment of a trout fishery in the 10-mile reach downstream of Olathe.

The diversion of the Uncompahgre River at Montrose and Olathe and the irrigation return flows drastically decreased the population of bottom organisms and eliminated environmental conditions suitable for trout.

UPPER DOLORES RIVER, COLORADO

Four waste sources were observed in the 42-mile reach of the Upper Dolores River:

(a) A gravel barrow pit located on the stream between stations 1 and 2;

(b) Drainage from the non-operating Rico Argentine Acid Plant located between stations 2 and 5;

(c) Wastes from the Rico Argentine Mining Company, discharged via Silver Creek between stations 5 and 9A; and

(d) Drainage from the non-operating Silver Swan Mine located between stations 9A and 10.

Upstream from Rico, Colorado, the Dolores River was a clean, gravel-bed trout stream supporting 11 different types of bottom organisms at a density of 143 per square foot, including stoneflies, mayflies and caddisflies (Table 20) which are indicative of unpolluted conditions, and the organisms provided an abundant source of fish food.

Heavy equipment was operating in the stream removing gravel for a road construction project during the survey. As a result, the total suspended solids (TSS) increased from 2 mg/1 upstream from the gravel operation (Station 1) to 312 mg/1 one-half mile downstream (Station 2).

This was an increase of 16,182 pounds of suspended sediments per 8-hour day. Silt traveled as a slug, and could be observed 20 miles downstream. The damaging effects of silt are many and varied, and usually act in conjunction with each other. Some of these are:

Conditions	Effects
Blocking out the sunlight	Reducing algal production
Covering algae	Limiting food for bottom organisms
Covering bottom organisms	Suffocating animals
Covering organism habitats	Eliminating living places for trout food organisms
Covering fish spawning grounds	Suffocating fish eggs

Maximum effects were observed at a point six miles downstream from the gravel operation, four miles downstream from Rico (Station 10). The delayed effect of the silt in reducing the benthic population was attributed to the drifting of bottom organisms from the clean-water reach upstream, and a stream velocity that precluded immediate silt settling. The TSS concentration at Station 10 was 220 mg/l, indicating that a portion of the silt had settled. Ninety-three percent of all bottom organisms had been eliminated at Station 10 (Figure 22). Twenty-four miles downstream (Station 12), benthic populations were only 37 percent of their original density. Forty miles downstream (Station 14), the population of bottom organisms had recovered to the level found upstream from the gravel barrow area (Figure 23); but gravel and spaces between the rocks were still covered with sufficient silt to suffocate

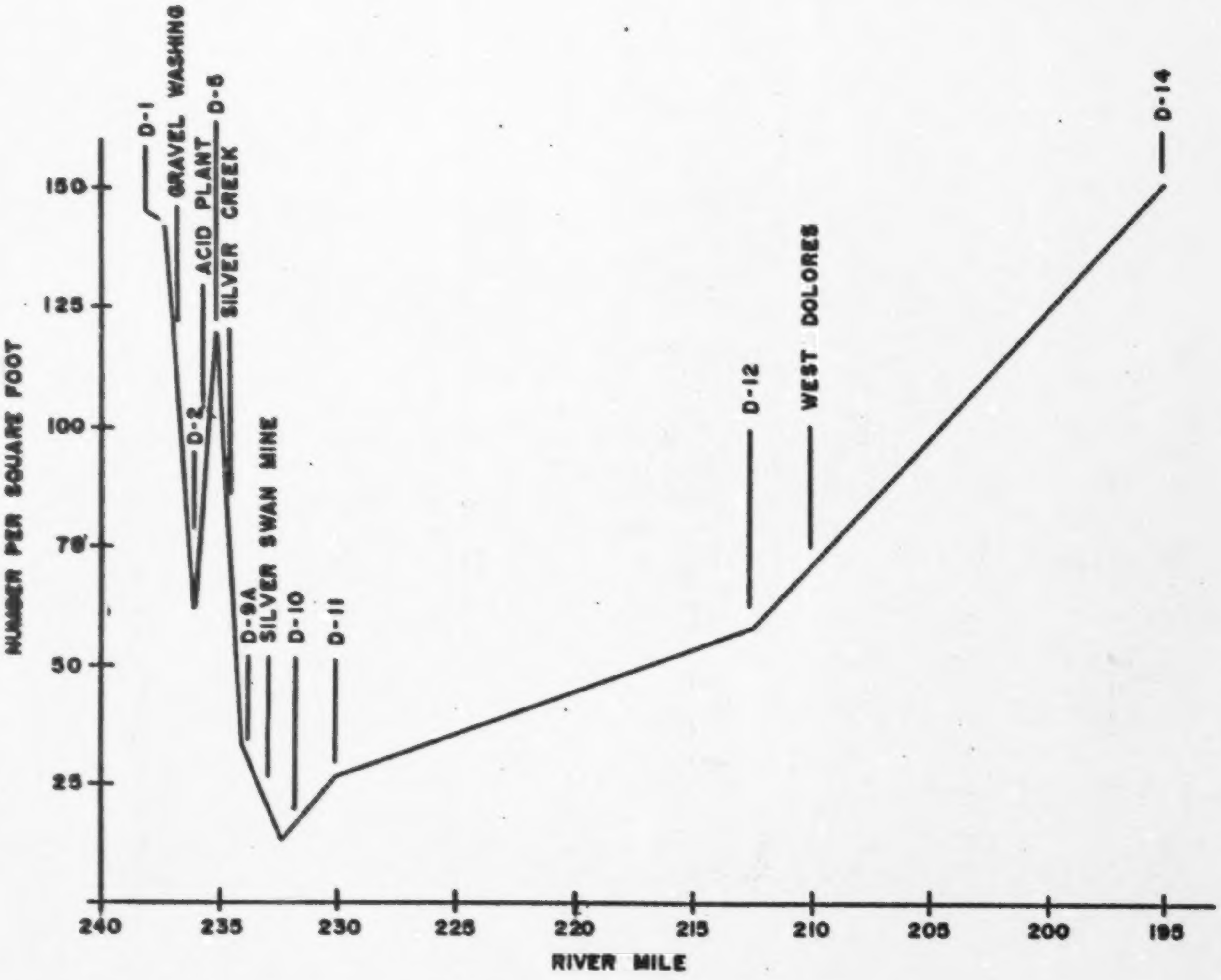

FIGURE 22. DOLORES RIVER, BOTTOM FAUNA DATA, NUMBER PER SQUARE FOOT, OCTOBER, 1966.

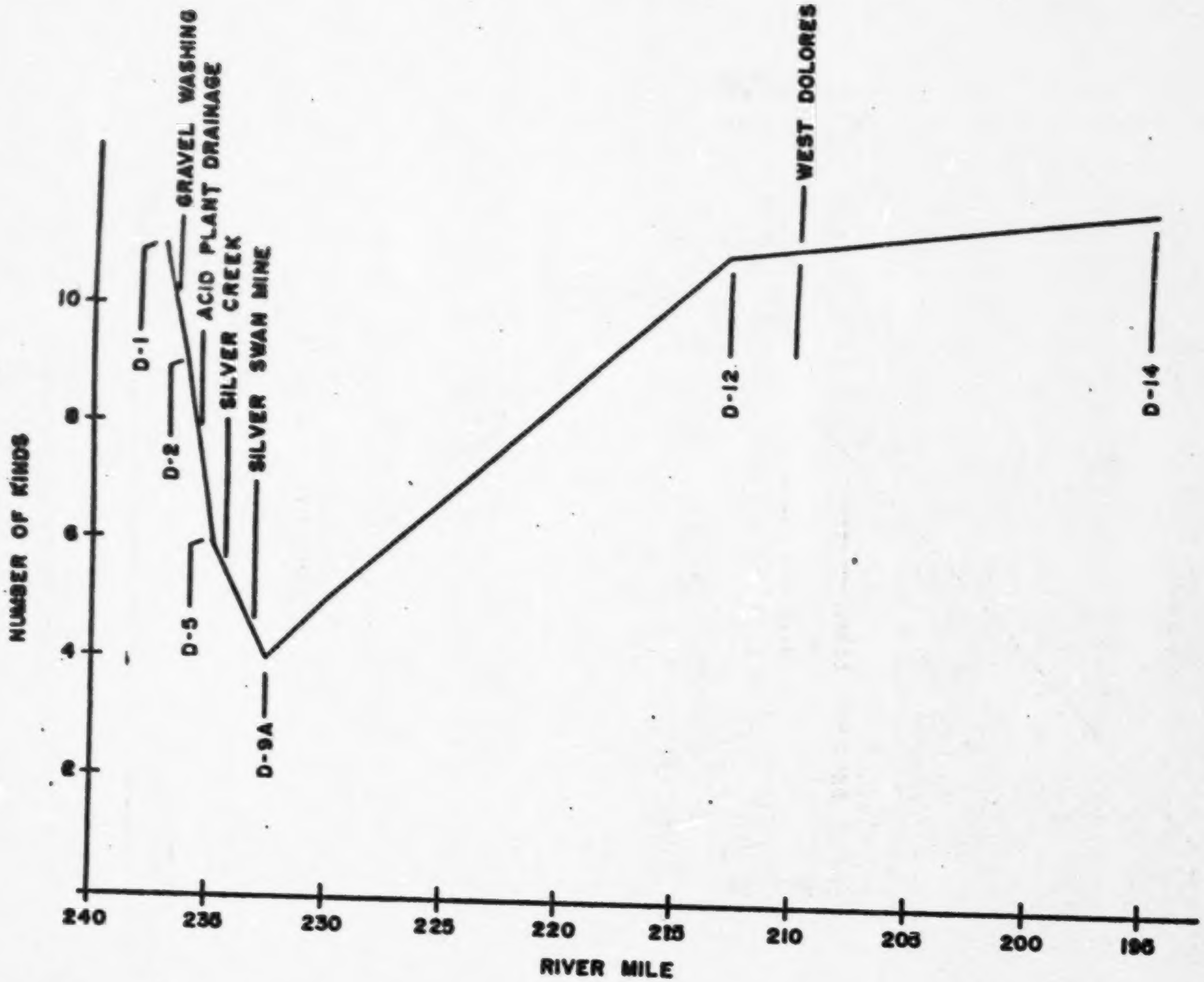

FIGURE 2B. DOLORES RIVER, BOTTOM FAUNA DATA, NUMBER OF KINDS, OCTOBER, 1966.

trout eggs. Silt not only covered eggs, but restricted the flow of water through the gravel.

Wastes from the non-operating Rico Argentine acid plant and the Rico Argentine and Silver Swan mines did not increase the stream concentrations of heavy metals to levels that are toxic to benthic organisms. Zinc was the only metal whose concentration at Station 10 had increased as compared to stations 2 and 5 (0.06 mg/l at Station 2 to 0.29 at Station 10). This concentration of zinc was not considered to be toxic since similar concentrations were observed at Station 10 on Tenmile Creek and at Station 40.1 on the Eagle River, and both supported good populations of benthic organisms at these locations.

The bottom organisms reached their greatest density at a point 15 miles downstream from the confluence of the West Dolores and Dolores Rivers. Upstream from the gravel operations at Station D-1, 11 kinds were present at a density of 143 per square foot; at Station D-14, 12 kinds numbering 150 per square foot comprised the benthic population.

In summary, silt from the gravel barrow pit operation on the Dolores River upstream from Rico, Colorado degraded at least 23 miles of stream (Figure 39). This degradation severely reduced the benthic animal populations that serve as trout food, and also covered the trout spawning grounds. Even if adult fish did survive the slugs of silt, they must depend on the aquatic invertebrates for the bulk of their diet. With the inorganic sediment reducing this food supply, there was no doubt that the gravel operation deleteriously affected the Dolores River trout.

LOWER DOLORES AND SAN MIGUEL RIVERS, COLORADO

The lower Dolores River and tributaries were surveyed during October 10 to 14, 1966 to determine whether the populations of aquatic life had improved following the closing of the Vanadium Corporation of America Mill at Naturita, the installation of waste treatment facilities at the Union Carbide mill at Uravan, and the containment of liquid wastes at the Idarado mill at Telluride.

Upstream from Bedrock, Colorado the Dolores River supported a population of clean-water organisms, composed of the pollution-sensitive mayflies, caddisflies and beetles. Diversion of water at Dolores, Colorado makes the flow insufficient to support a fishery. Three miles downstream from Bedrock the river was devoid of aquatic organisms as a result of largely increased chlorides and sulfates occurring naturally from large salt springs in Paradox Valley.

The San Miguel River rises in the San Juan Mountains southeast of Telluride, Colorado and joins the Dolores River six miles downstream from Bedrock, Colorado. Three streams, Marshall, Ingram and Bridal Veil creeks, enter the San Miguel near the Idarado mine just upstream from Telluride. Marshall Creek and its tributary, Savage Creek, were devoid of aquatic life because of zinc concentrations of 6.0 and 2.6 mg/l, respectively. In addition, Marshall Creek had a manganese concentration of 13.8 mg/l. These high concentrations of metals result from mine drainage and land runoff.

Other major headwater streams of the San Miguel River are the Meldrum Tunnel Drain and Bridal Veil Creek, both entering the San Miguel upstream from Telluride. Waters from the Meldrum Tunnel contained an iron concentration of 1.0 mg/l and a zinc concentration of 1.2 mg/l (SM-7). Concentrations of iron and zinc in Bridal Veil Creek (SM-5) were < 0.2 and 0.04 mg/l respectively, permitting the development of an abundant population of organisms numbering 13 kinds with a density of 147 per square foot. Another minor tributary to the San Miguel River, Ingram Creek, supported no aquatic organisms because of its intermittent flow (SM-6). During the survey Ingram Creek had a zinc concentration of 0.47 mg/l.

Upstream from the Idarado Mine (SM-8), the San Miguel River supported seven kinds of organisms with a population density of 51 per square foot (Figure 24). These organisms lived in an environment containing 0.45 mg/l of zinc. Downstream from Marshall Creek (SM-9), the concentration of zinc increased to 2.3 mg/l, and manganese from 0.1 to 3.3 mg/l as a result of mine drainage to Marshall Creek. In the two-mile reach from the Idarado mine to Telluride, only one organism per square foot was found (SM-10). One hundred-fifty yards downstream from Telluride, aquatic organisms carried in small tributary streams began to reinhabit the San Miguel River (Figure 25). Here the various metal concentrations were below toxic levels for certain organisms. At this station (SM-11) the concentration of iron was 0.3, manganese 1.0, and zinc 0.62 mg/l (Table 22). The population of bottom organisms decreased

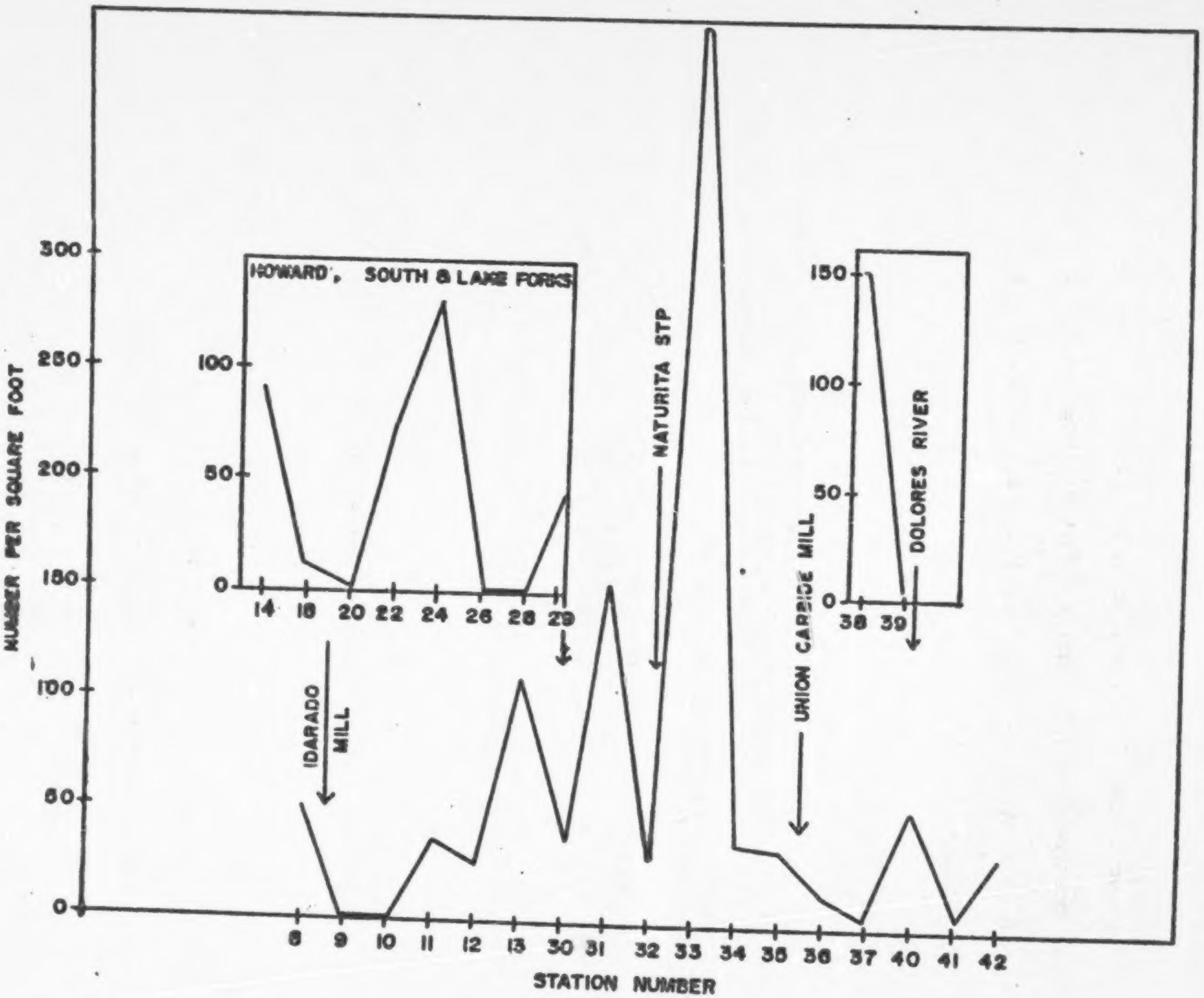

FIGURE 24. SAN MIGUEL, HOWARD'S FORK AND DOLORES RIVERS, NUMBER OF BOTTOM ORGANISMS PER SQUARE FOOT, OCTOBER 1966.

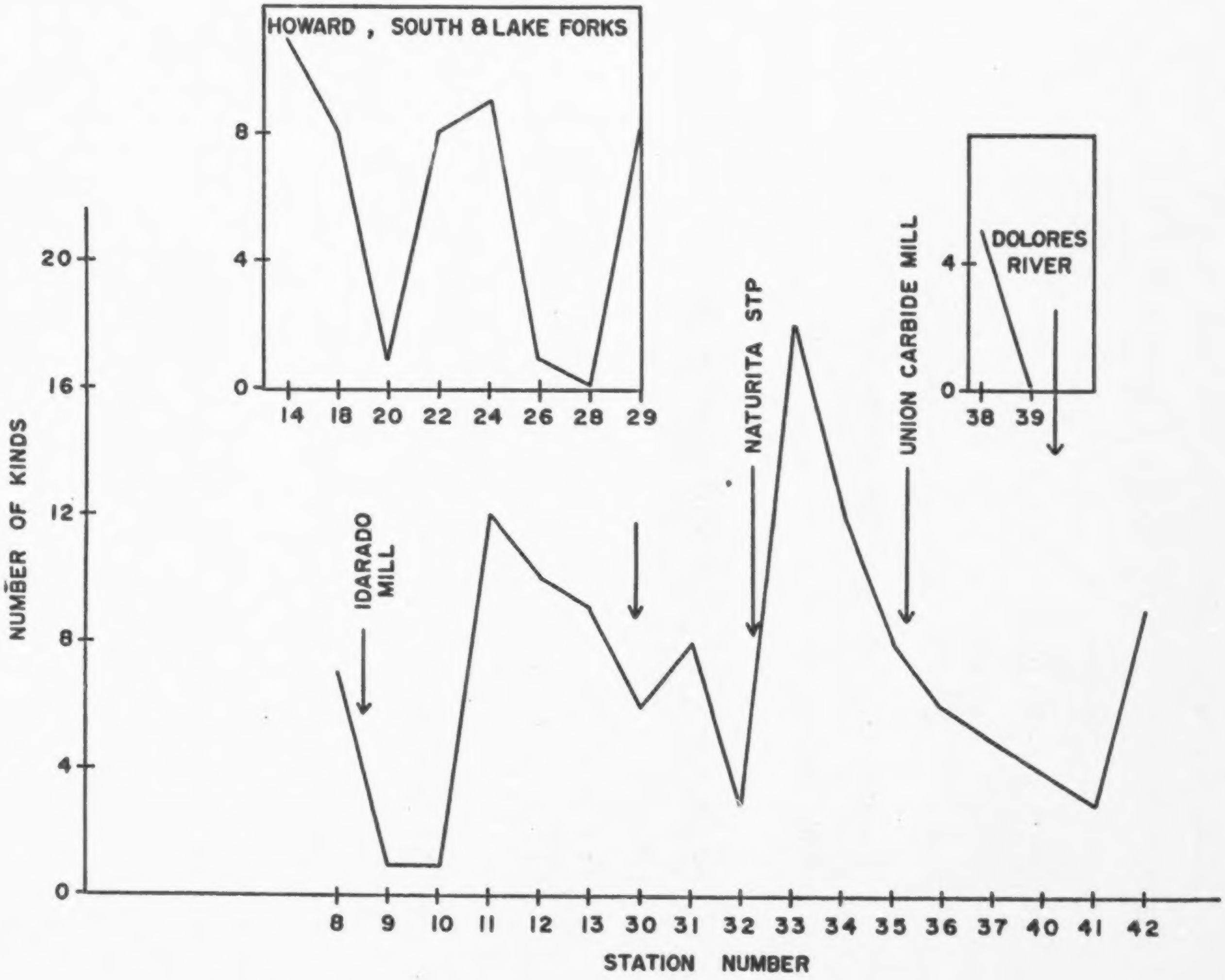

FIGURE 25. SAN MIGUEL , HOWARD'S FORK AND DOLORES RIVERS , NUMBER OF KINDS OF BOTTOM ORGANISMS , OCTOBER 1966.

slightly between SM-11 and SM-12, but regained in number downstream to the South Fork, a distance of three miles (SM-13).

The South Fork is formed by the confluence of Howard Fork and Lake Fork. Upstream from Ophir, Colorado the Howard Fork supported a population of bottom organisms numbering 147 per square foot with 13 kinds (SM-14). As a result of mine drainage, between stations SM-14 and SM-18 the population of bottom organisms decreased to 18 per square foot with a diversity of eight kinds. This reduction in bottom organisms indicated that the mine drainage had a toxic effect on a portion of the stream biota, and limited the recreational use of the stream. Downstream from an iron paint pigments quarry (SM-20), only one organism was collected, emphasizing the toxic effects of drainage from this source. This drainage increased the iron concentration in Howard Fork to 22 mg/l which was toxic to aquatic life.

Just upstream from Silver Bell Mine (SM-24) in Ophir, Colorado Howard Fork continued to recover biologically. Here the bottom organisms numbered 130 per square foot with a diversity of nine kinds, the majority of them associated with clean water. During the survey, no adverse effects of mine drainage were observed in the remaining reaches of Howard and South Forks (SM-26-29). The South Fork of the San Miguel River enters the main stream about nine miles downstream from the confluence of the Howard and Lake forks. About three-fourths of a mile upstream from its mouth the South Fork supported a population of 47 organisms per square foot, made up of eight kinds, primarily the sensitive caddisflies, mayflies and stoneflies. Chemical analyses of the water here showed all toxic materials to be below the critical level; iron and zinc concentrations were 0.5 and 0.06 mg/l, respectively.

The quality of the San Miguel River had improved since a survey of the stream in October 1962.* The earlier survey showed that the San Miguel River three miles downstream from Telluride (SM-12) supported only one organism per square foot, compared to the 26 organisms per square foot, made up of 10 kinds found in 1966. This marked change may have come about after the Idarado Mill (mentioned in the 1962 biological report) began its present practice of discharging to tailings ponds. Samples of seepage from the ponds have shown no objectionable levels of toxicity. However, further study is needed to determine the pollution potential associated with seepage and erosion from all types of tailings piles in the basin.

The San Miguel River downstream from the South Fork (SM-30) continued to show aquatic life improvement in 1966 over 1962, the populations having increased from 77 to 124 organisms per square foot. The reach of the San Miguel River between the South Fork confluence and Naturita, Colorado supported a population of bottom organisms typical of a clean water stream. This reach of stream is noted for its rainbow trout production.

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* Letter correspondence from Croswell Henderson to J. M. Rademacher, Project Director, Colorado River Basin Project, dated July 29, 1964.

Organic enrichment of the San Miguel results from the discharge of wastes from the Naturita sewage treatment plant, evidence in the increased number of bottom organisms. The population increased from 156 per square foot at Norwood (SM-31) to 484 just downstream from Naturita (SM-33). Under conditions of lower flow or increased waste discharges, this enrichment could eliminate the pollution-sensitive organisms and limit the fish food supply. The sparse population of bottom organisms observed just upstream from Uravan, Colorado (SM-34) apparently was caused by large quantities of silt carried into the San Miguel River by heavy runoff from areas containing little vegetation. In the reach downstream from Naturita, the increased silt load changes the San Miguel River from a trout stream to a warm water stream supporting catfish and bass.

As a result of waste from the Union Carbide Corporation mill at Uravan, the population of bottom organisms decreased from 37 per square foot (SM-35) to nine per square foot (SM-37). Installation of waste treatment facilities at the Union Carbide mill since the 1962 survey has been instrumental in increasing the population of bottom organisms. The earlier survey showed only one organism per square foot. However, the treatment facilities have only lessened the toxic effects of the Union Carbide wastes, but have not completely eliminated them from the San Miguel River.

The San Miguel River flows into the Dolores River approximately three miles downstream from the Union Carbide mill. Six miles downstream from this confluence the Dolores River supported four kinds of organisms with a population density of 54 per square foot, indicating that the river was continuing to recover biologically from the effects of both the Union Carbide wastes at Uravan and the high salt concentrations.

The Dolores River flows through an area of highly erodible soils so that, between its intermittent riffles, the river bed is composed of pools with fine sediment bottoms. Rocks of the riffles, too, were often covered with fine sediments, thus reducing the habitat for bottom organisms. A sample (SM-41) collected in this reach yielded only three kinds of organisms with a density of seven per square foot; whereas 25 miles downstream at Gateway, Colorado (SM-42), a sample produced 33 organisms per square foot with a diversity of nine kinds.

In summary, mine drainage upstream from Telluride, Colorado degraded Marshall and Savage creeks by contributing sufficient zinc to be toxic to aquatic organisms. Elimination of some of the aquatic life upstream from Telluride deprived the local community of a trout fishery that could provide economic benefit.

Near Ophir, Colorado, mine drainage to Howard Fork reduced but did not completely eliminate the aquatic life. Additional drainage from a paint pigment quarry because of high iron concentrations, eliminated all but one form of bottom organism. Because of these conditions, the community of Ophir is deprived of a potentially good trout fishery.

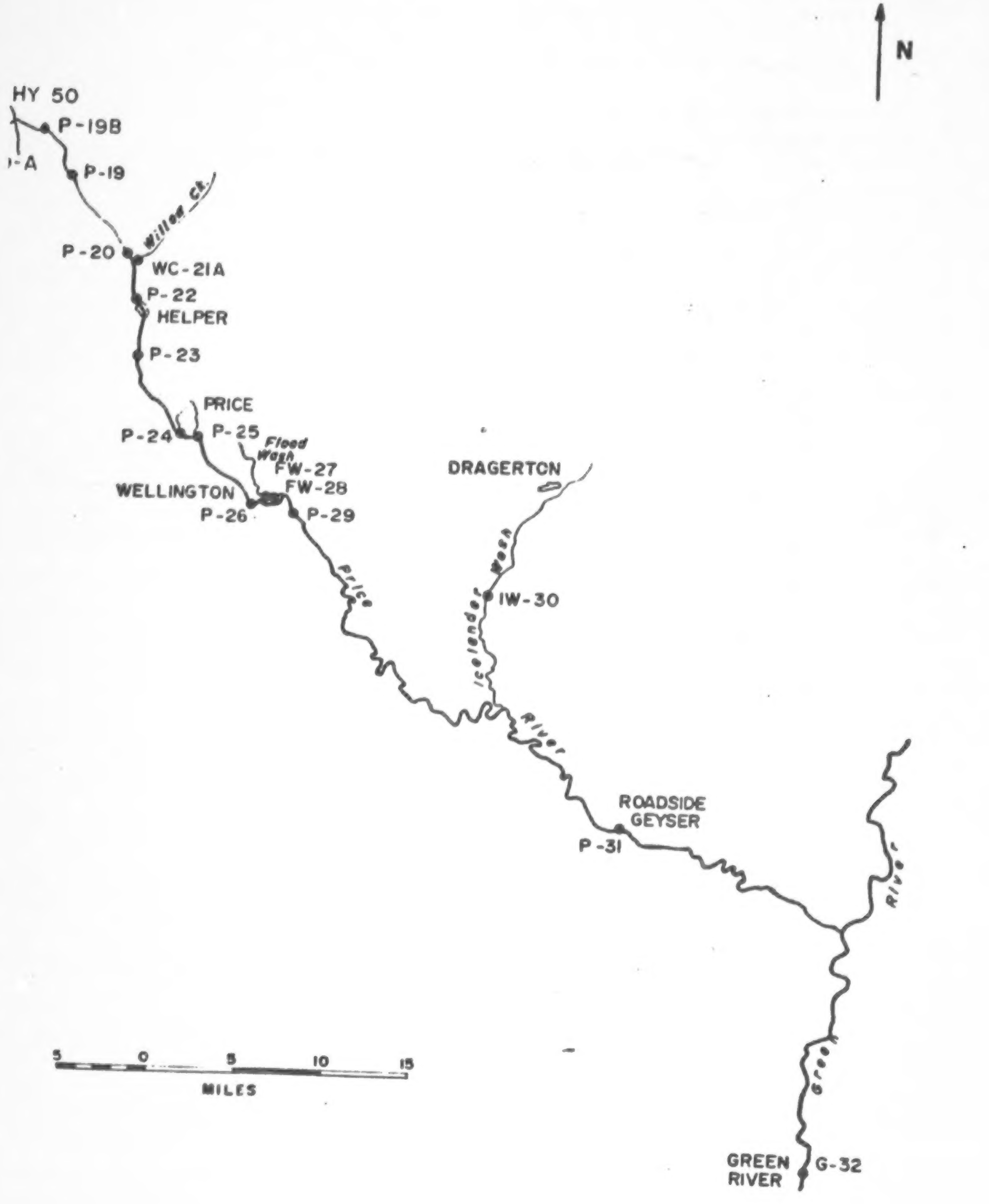
In the vicinity of Uravan, Colorado, the San Miguel River was biologically degraded by Union Carbide mill wastes (Figure 39). Despite some improvement since 1962, toxic materials were still being discharged to the river, as reflected in the small population of bottom organisms observed in the 1966 survey.

In the area of Bedrock, Colorado the Dolores River was degraded by drainage from large natural salt outcropping in Paradox Valley. Upstream from its confluence with the Colorado at Gateway, Colorado, the Dolores River benthic populations indicated the river had recovered from wasteloads farther upstream.

PRICE RIVER, UTAH

The Price River from Scofield Reservoir downstream to the Highway 50 crossing was an unpolluted trout stream, supporting 347 organisms per square foot with a diversity of 18 kinds (Station 19A). Two miles downstream from this station, the Price River was degraded by sediment washed into the creek from runoff over the barren ground. This sediment, of very small particle size, smothered the organisms, and blanketed their habitat. The benthic population 3 miles downstream

FIGURE 26.



STUDY AREA
PRICE RIVER SURVE

N
HY 50
P-19B
-A
P-19
Willow Ck.
P-20
WC-21A
P-22
HELPER
P-23
PRICE
P-24
P-25
Flood Wash
FW-27
FW-28
WELLINGTON
P-26
P-29
DRAGERTON
Icelander Wash
IW-30
Price River
ROADSIDE GEYSER
P-31
River
Green
GREEN RIVER
G-32
5 0 5 10 15
MILES

from the Highway 50 bridge numbered 87 per square foot with a diversity of 17 (Station 19B). This amounted to 75 percent reduction in the available fish food (Figure 27). The bottom organisms population downstream recovered to the magnitude observed upstream at Station 19A. Electrofishing upstream from the Highway 50 bridge yielded trout, but downstream, in the area receiving the sediment-bearing runoff, no trout were captured.

In the reach of river from Highway 50 to the diversion at Helper, Utah, the reduced population of bottom organisms was predominatly (91 percent) the pollution-sensitive forms such as mayflies and caddisflies (Table 24). This is a result of natural degradation rather than man-induced pollution. Downstream from the diversion at Helper (P-24), no organisms were found inhabiting the fine silt substrates (Figure 28). Downstream from Wellington, Utah (P-26), pollution-tolerant midges and sludgeworms predominated indicating the discharge of large quantities of organic pollution from the municipalities of Wellington and Price. This pollution was dissipated in the 60-mile reach downstream to Woodside, Utah (P-31) where the bottom organisms were predominantly pollution-sensitive caddisflies and black flies.

The Green River, downstream from its confluence with the Price River, supported a population of bottom organisms typical of clean waters.

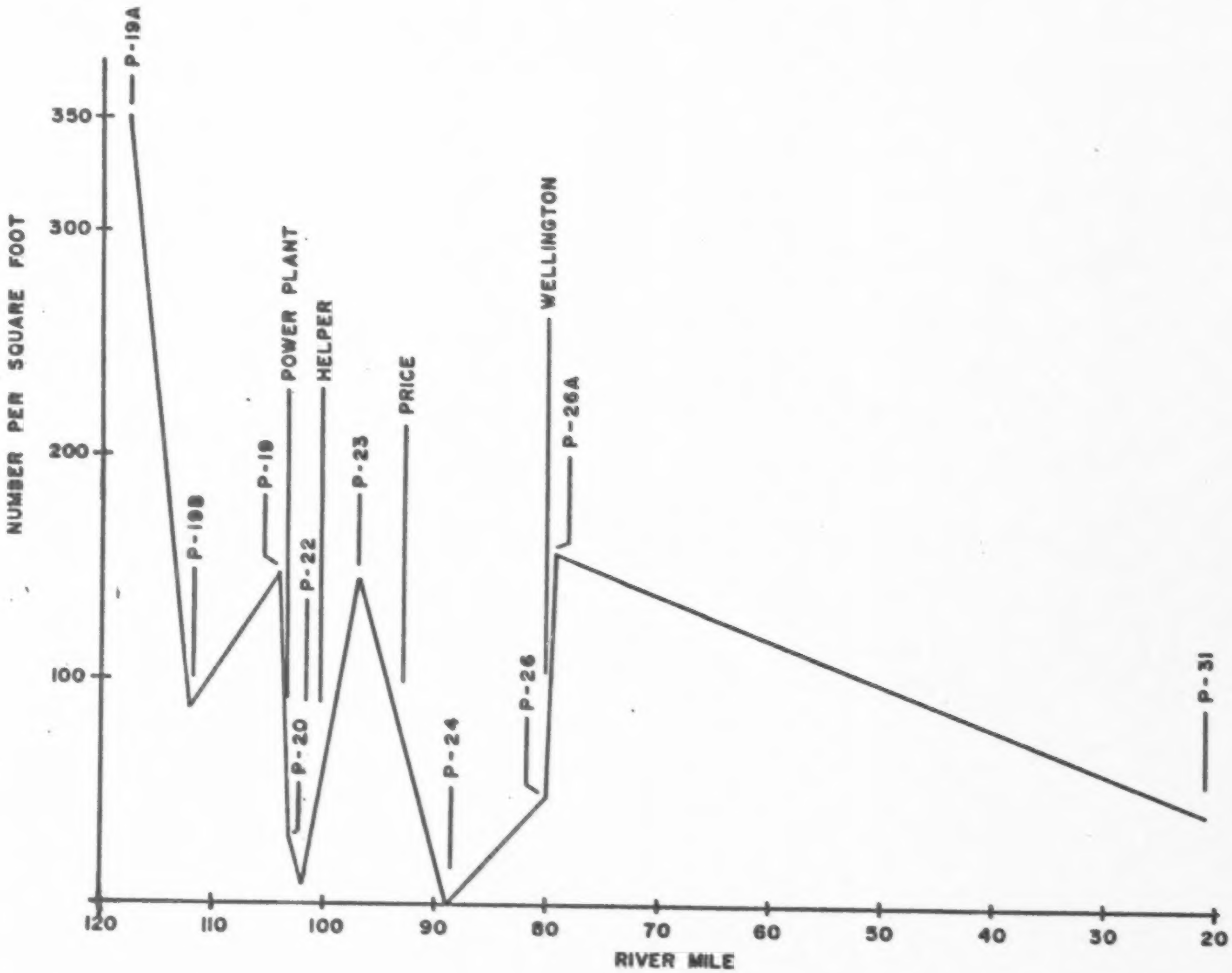


FIGURE 27. PRICE RIVER, NUMBER PER SQUARE FOOT OF BOTTOM ORGANISMS, JULY-AUGUST, 1966.

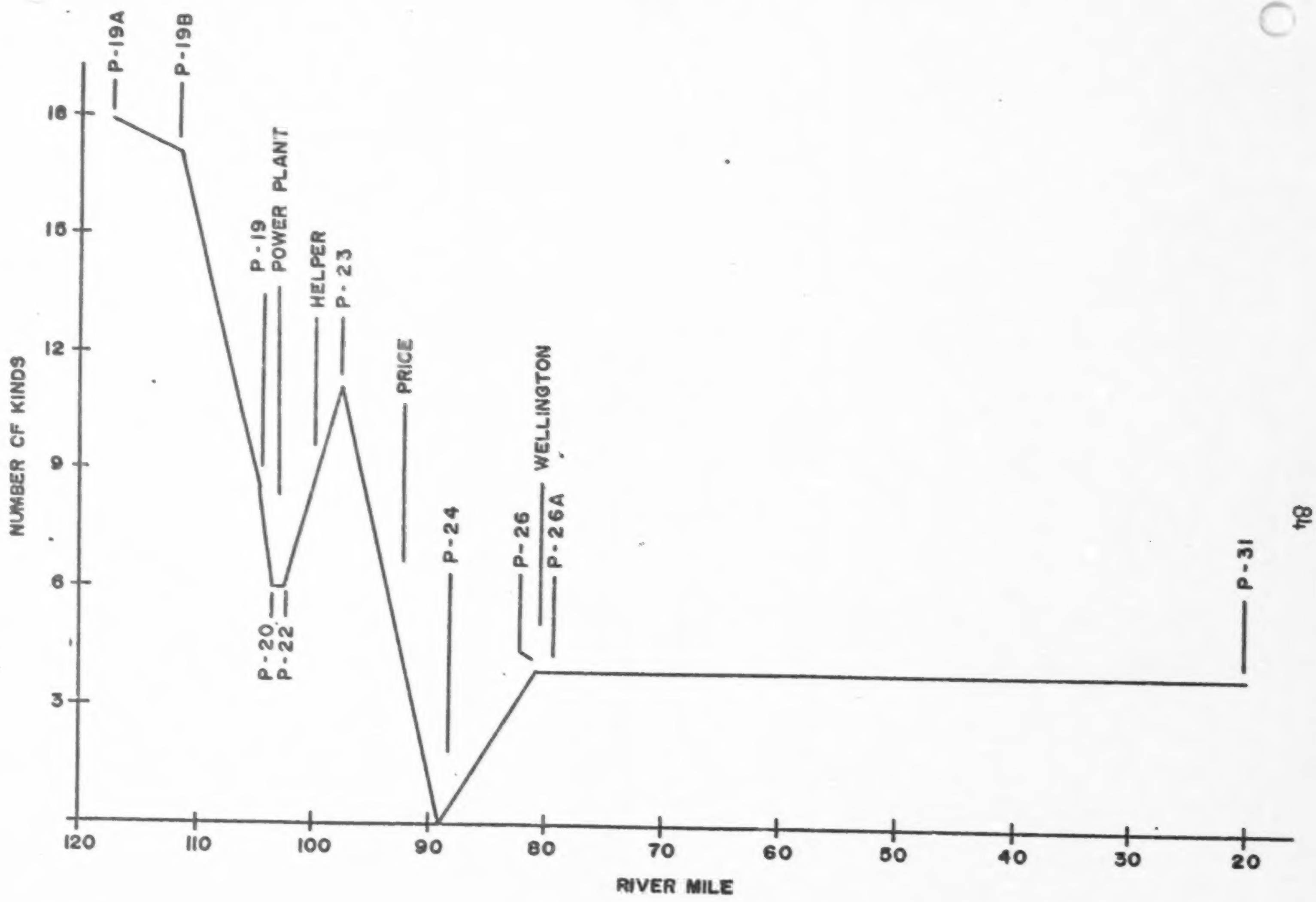


FIGURE 28. PRICE RIVER, NUMBER OF KINDS OF BOTTOM ORGANISMS, JULY–AUGUST 1966.

In summary, the Price River was degraded by both natural runoff and organic wastes discharged from Price and Wellington, Utah (Figure 39). These discharges resulted in populations of bottom organisms predominated by sludgeworms. Farther downstream the Price River recovered biologically so that it does not affect the aquatic life of the Green River at Green River, Utah.

SAN JUAN RIVER, COLORADO, NEW MEXICO, UTAH

The bottom organisms of San Juan River, upstream from Pagosa Springs, Colorado, were typical of an unpolluted stream; they numbered 160 per square foot with a diversity of 12 kinds (SJ-10). Nine of these 12 kinds and 91 percent of all organisms were the pollution-sensitive stoneflies, mayflies and caddisflies. Just upstream from Navajo Lake (SJ-8) the number of bottom organisms (Figure 32) was reduced to 77 per square foot, although the same 12 kinds were still present (Figure 33), indicating that sulfites flowing in from natural mineral springs were toxic to some of the bottom organisms. Upstream from Navajo Lake, the San Juan River had a maximum temperature of 25.5°C from July 12-23, 1967, which is suitable for trout.

The Piedra River, another major river entering the Navajo Reservoir near Arboles, Colorado, also supported bottom organisms typical of an unpolluted river. The Piedra River provided excellent trout fishing in the reach upstream from the reservoir.

The Los Pinos River, a famous trout stream, enters the Navajo Reservoir near the dam. It supported an abundant population of bottom

FIGURE 29.
STUDY AREA
SAN JUAN RIVER SYSTEM SURVEY

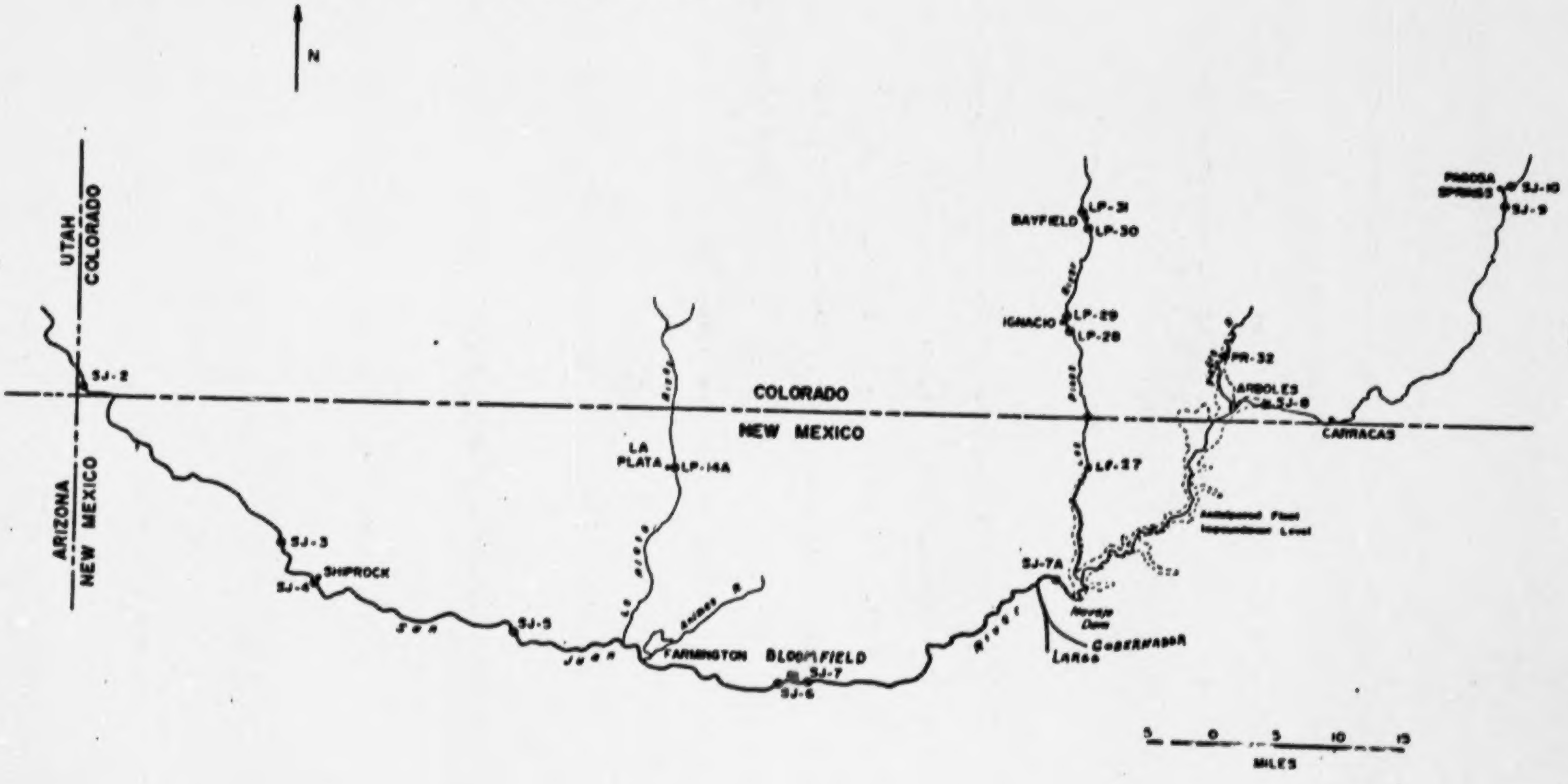

N
UTAH
COLORADO
ARIZONA
NEW MEXICO
SJ-2
COLORADO
NEW MEXICO
SJ-3
SHIPROCK
SJ-4
San
SJ-5
Juan
LA
PLATA
LP-14A
Animas R
FARMINGTON
BLOOMFIELD
SJ-7
SJ-6
River
SJ-7A
Navajo
Dam
Largo
Gobernador
BAYFIELD
LP-31
LP-30
IGNACIO
LP-29
LP-28
LP-27
PR-32
ARBOLES
SJ-8
CARRACAS
Anticipated Pool
Impoundment Level
PAGOSA
SPRINGS
SJ-10
SJ-9
5
0
5
10
15
MILES

FIGURE 30.
STUDY AREA
ANIMAS RIVER SURVEY

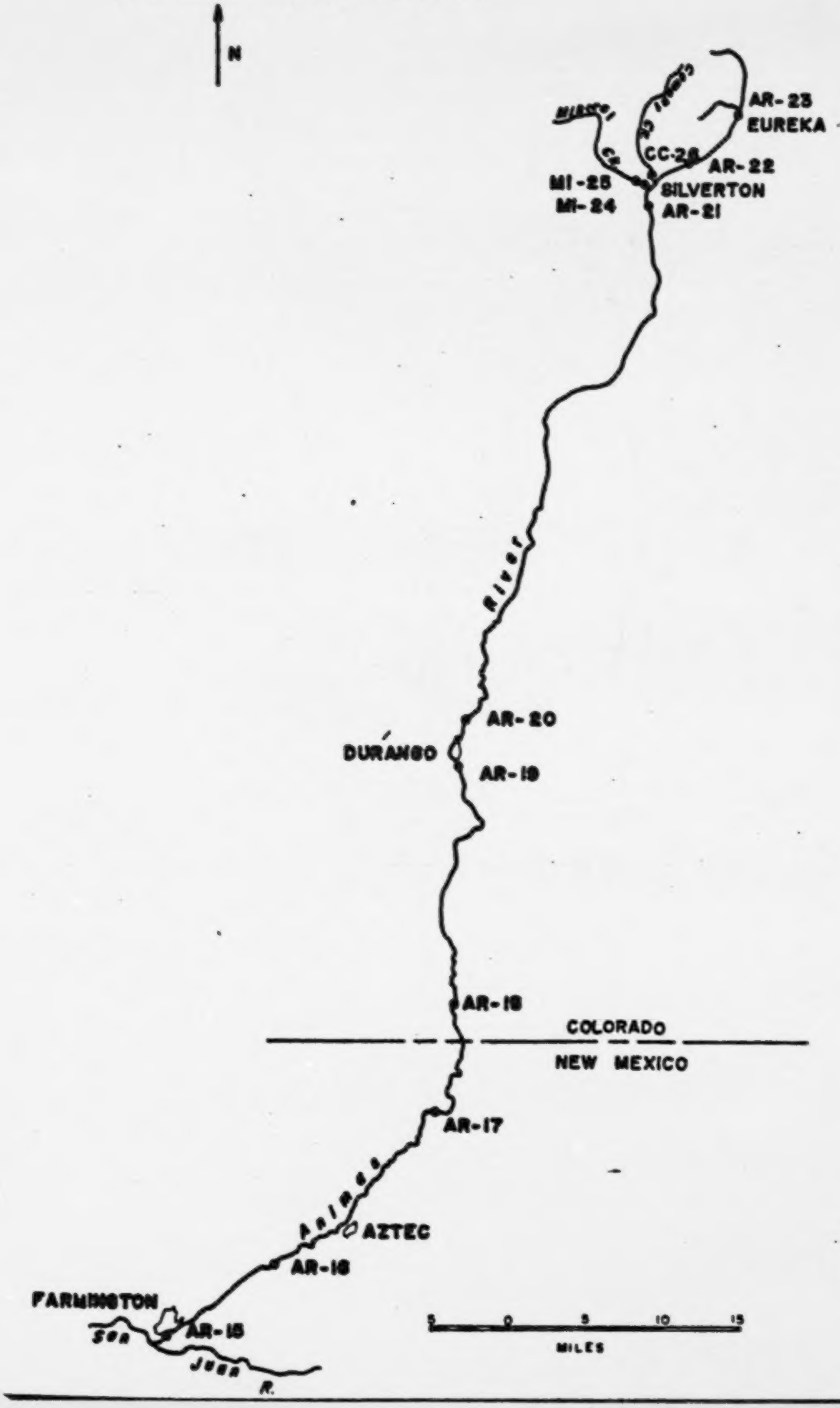
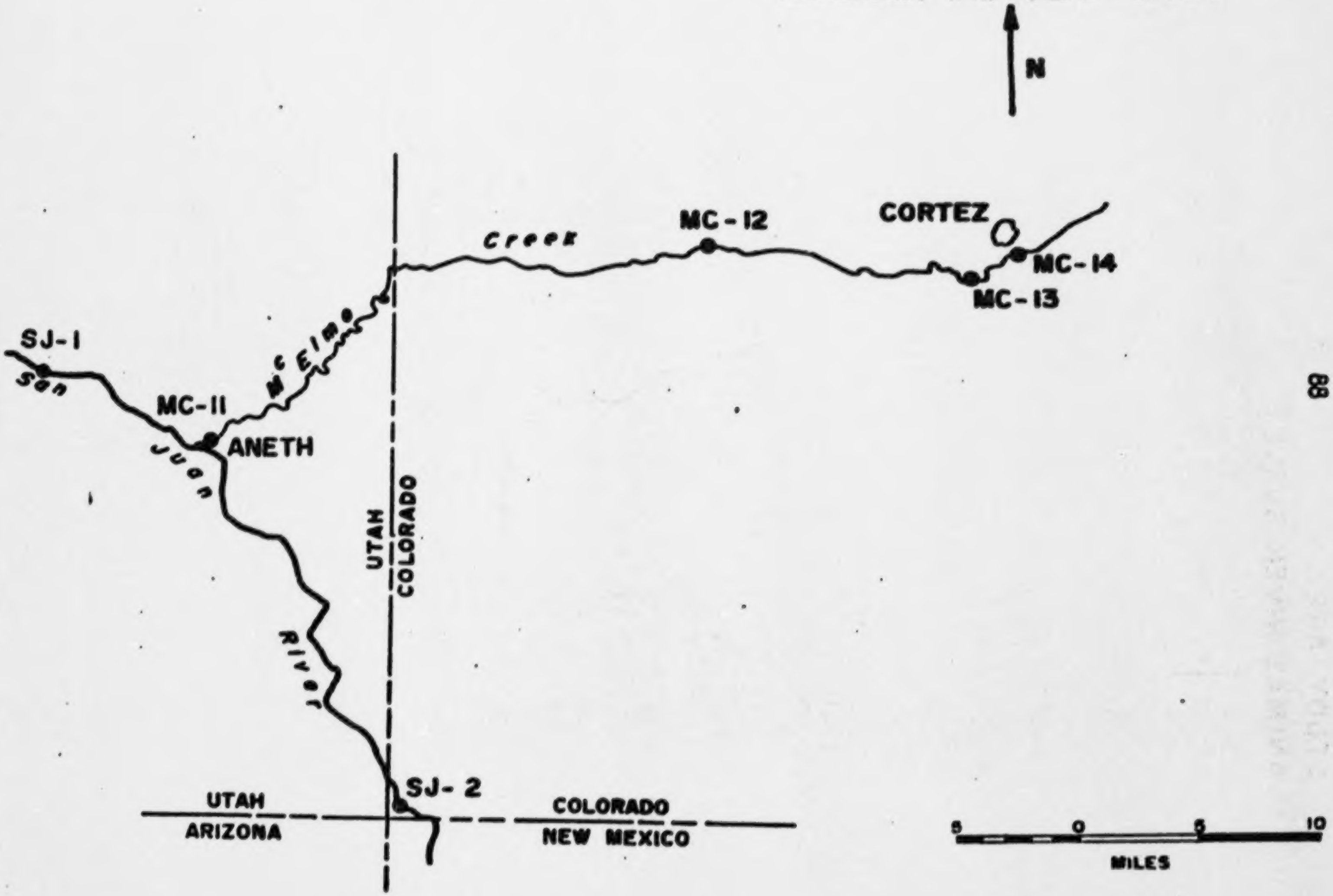

N
Mineral Ck
Cement Ck
AR-23
EUREKA
CC-26
AR-22
MI-25
MI-24
SILVERTON
AR-21
River
AR-20
DURANGO
AR-19
AR-18
COLORADO
NEW MEXICO
AR-17
Animas
AZTEC
AR-16
FARMINGTON
AR-15
San Juan R.
5 0 5 10 15
MILES

FIGURE 31.

STUDY AREA
McELMO CREEK SURVEY


N
CORTEZ
MC-12
MC-14
MC-13
Creek
McElmo
SJ-1
San
MC-11
ANETH
Juan
River
UTAH
COLORADO
SJ-2
UTAH
ARIZONA
COLORADO
NEW MEXICO
5
0
5
10
MILES

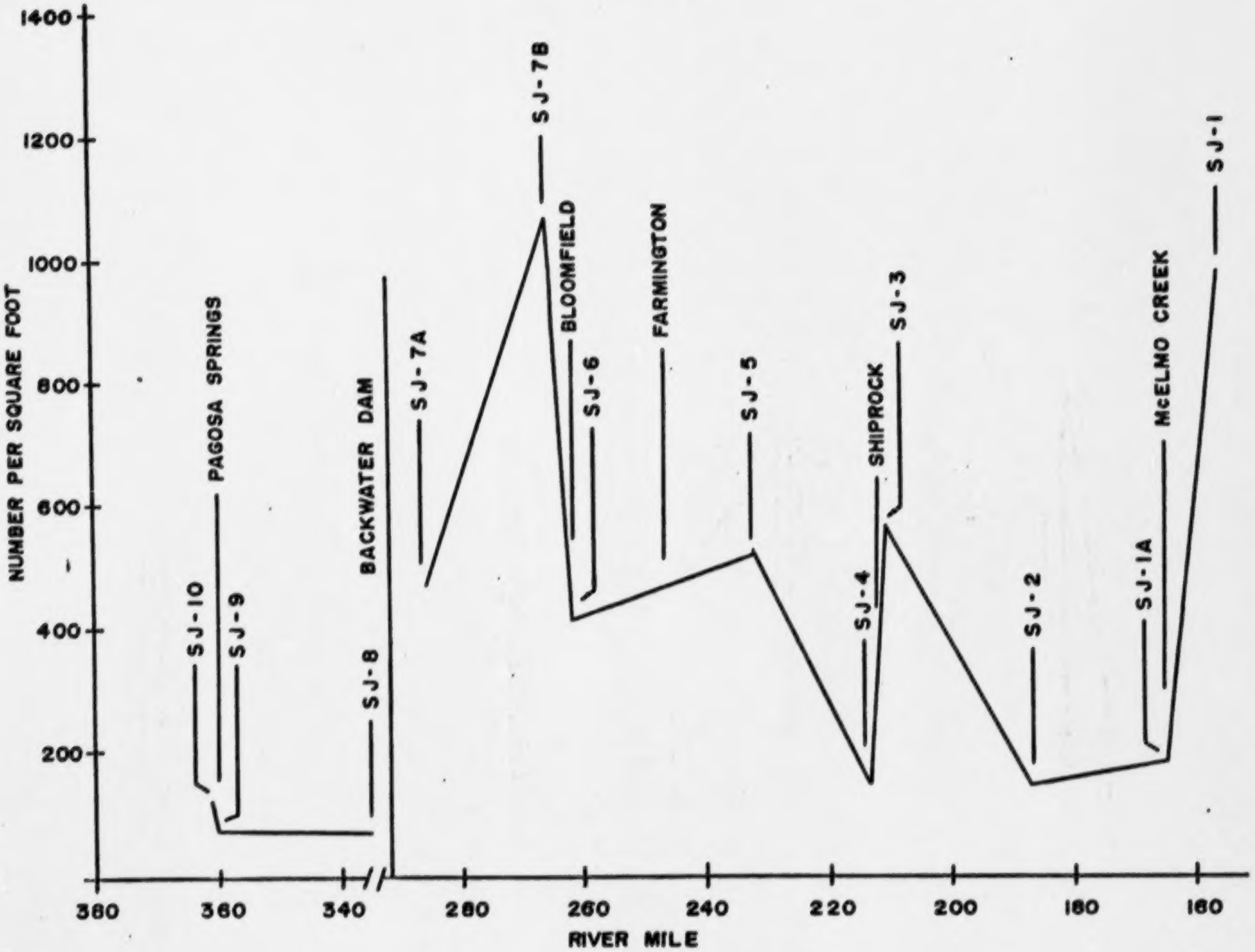


FIGURE 32. SAN JUAN RIVER, NUMBER OF BOTTOM ORGANISMS PER SQUARE FOOT, JULY-AUGUST 1966.

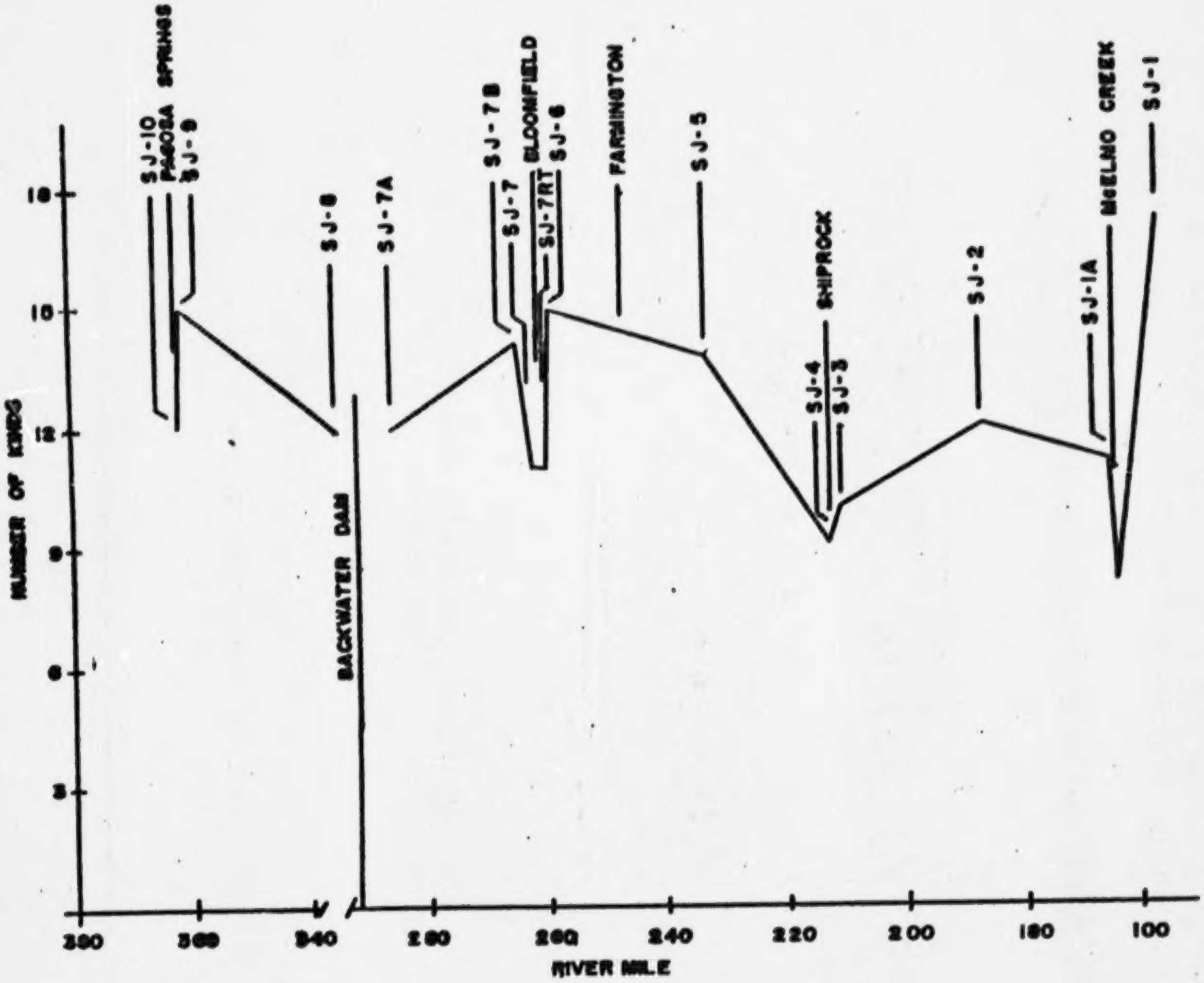


FIGURE 38. SAN JUAN RIVER, NUMBER OF KINDS OF BOTTOM ORGANISMS, JULY-AUGUST 1966.

organisms. At Station LP 27 on the Los Pinos just upstream from the Reservoir, 72 percent of the organisms were the pollution-sensitive varieties.

The San Juan River, downstream from the Navajo Dam to Gobernador Wash, supports a trout fishery. In the reach downstream to Canyon Largo, trout fishing becomes limited. The total reach of stream suitable for trout fishing is 18 miles. Two factors change the San Juan River to make it unsuitable for trout: (1) the water temperature increases because of naturally unforested stream banks, and (2) the stream channel is shallow and wide. At Station SJ-7A, the maximum temperature during the survey was 19°C. while at Station 7 the maximum reached 27°C. Another factor contributing to alteration of the trout environment is the large quantity of sediment washed into the river during periods of high runoff. Upstream from Gobernador Wash and Canyon Largo (SJ-7A), the maximum turbidity was 26 units, and the maximum total solids was 48 mg/l. Downstream from these intermittent streams (SJ-7), but during a period of heavy rains and high runoff, the maximum turbidity reached 40,000 units and the solids over 50,000 mg/l. Although these high sediment concentrations were of short duration, most of the fish, especially the more susceptible trout, were eliminated. Bottom organism populations were restored or maintained by the drifting of organisms from upstream riffles. The San Juan River downstream from Canyon Largo, to its confluence with the Colorado, supported warm-water fish, such as dace, suckers, catfish and carp.

Downstream from Navajo Dam for 130 miles, the aquatic life typified an unpolluted river. In this reach the riffle areas supported from 9 at Shiprock (SJ-4) to 17 (SJ-1) varieties of bottom life. In all samples, clean-water associated organisms, such as stoneflies, mayflies and caddisflies were predominant (Table 26). An exception was a 3-mile reach at Bloomfield, New Mexico where the intermediately pollution-tolerant midges were present in large number. This condition indicated some organic enrichment from the Bloomfield, New Mexico sewage treatment plant.

No degradation of the aquatic life inhabiting the San Juan River was observed downstream from the confluences of the Animas River or McElmo Creek. The Animas River was studied from the abandoned town of Eureka, Colorado to Farmington, New Mexico. Biological surveys were conducted on the Animas and tributary streams in the Silverton, Colorado area to determine the effect of mine drainage on aquatic life, and in the Durango, Colorado, area to determine if the closing of the Vanadium Corporation of America mill at that point had resulted in improved populations of fish and other aquatic life since a 1961 biological survey.

Upstream from Silverton, Colorado the Animas River supported only a sparse population of bottom organisms composed of 4 kinds and 20 individuals per square foot (Table 28). Aquatic life in the river near Eureka, Colorado was limited by the toxic materials discharged from upstream mines. During July 1966, the zinc concentration ranged from 0.4 to 0.7 mg/l and averaged 0.46 mg/l at Station AR-22. Electrofishing in this reach produced one trout, indicating that fish could survive, but in very low numbers. Upstream from Silvertown, the Animas River could support trout on a put-and-take basis if the population of bottom organisms were not limited by toxic metals.

Cement and Mineral Creeks join the Animas River at Silverton, Colorado. Upstream mine drainage limits the population of bottom organisms in Cement Creek to 2 kinds at a density of only 9 per square foot. Mineral Creek, just upstream from its confluence, supported a population of bottom organisms numbering 16 per square foot with a diversity of 6 kinds. The toxicity in Cement Creek was attributed to high concentrations of zinc and iron; average values observed during the period July 12-23, 1966 survey were 2.1 and 6.9 mg/l, respectively. The toxicity in Mineral Creek was attributed to a maximum concentration of 2.15 mg/l of iron. The toxicity observed in Cement and Mineral Creeks was also evident in the Animas River downstream from their mouths as indicated by reduced bottom organism populations. The greatest reduction was in the main channel, which carried the Cement Creek flow. This toxicity adversely affected the benthic population for several miles downstream (Figure 34). Approximately 50 miles downstream in the Animas River, a population of bottom organisms capable of supporting trout was present at Durango.

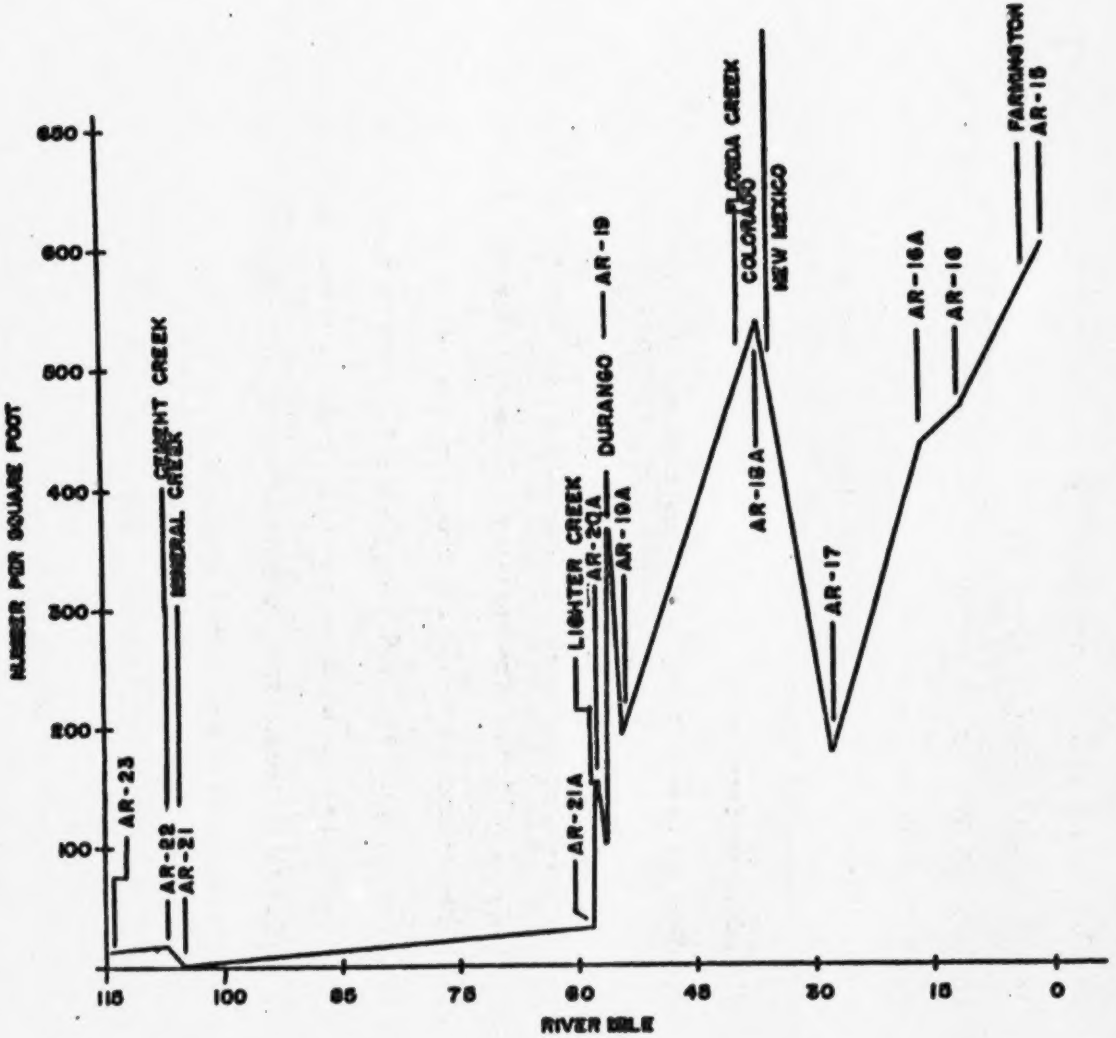


FIGURE 34. ANIMAS RIVER, NUMBER OF ORGANISMS PER SQUARE FOOT, JULY 1966.

The Animas River at the upstream edge of Durango, Colorado (AR-20A) supported a population of bottom organisms indicative of clean water. The population contained 154 organisms per square foot at diversity of 10 kinds. Eight of these 10 kinds, and 85 percent of the total population, were pollution-sensitive organisms. The State of Colorado stocks trout in the Animas River from Durango to the New Mexico State line. Before the closing of the Vanadium Corporation of America mill at Durango in 1963, the aquatic life of the river was adversely affected downstream to its confluence with the San Juan River as shown in the 1958 and 1959 Public Health Service surveys.* The population of bottom organisms in 1959 decreased from 360 organisms per square yard upstream from the Vanadium Corporation of America mill to 2 organisms per square yard in the reach downstream from the mill to Cedar Hill, New Mexico (Figure 35). This decrease was attributed to toxic wastes discharged by the mill. In 1966, the population of bottom organisms increased from 277 organisms per square yard at AR-20A to 3,034 organisms per square yard, mostly clean water caddisflies, at the confluence of Florida Creek (AR-18A) and then decreased to 230 organisms per square yard at Cedar Hill, New Mexico

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*Tsivoglou, E. C., S. D. Shearer, J. D. Jones, C. E. Sponagle, H. R. Pahren, J. B. Anderson and D. A. Clark. 1960. Survey of interstate pollution of the Animas River (Colorado-New Mexico) II. 1959. Surveys. U. S. Public Health Service, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio pp. 153 (Mimeo.)

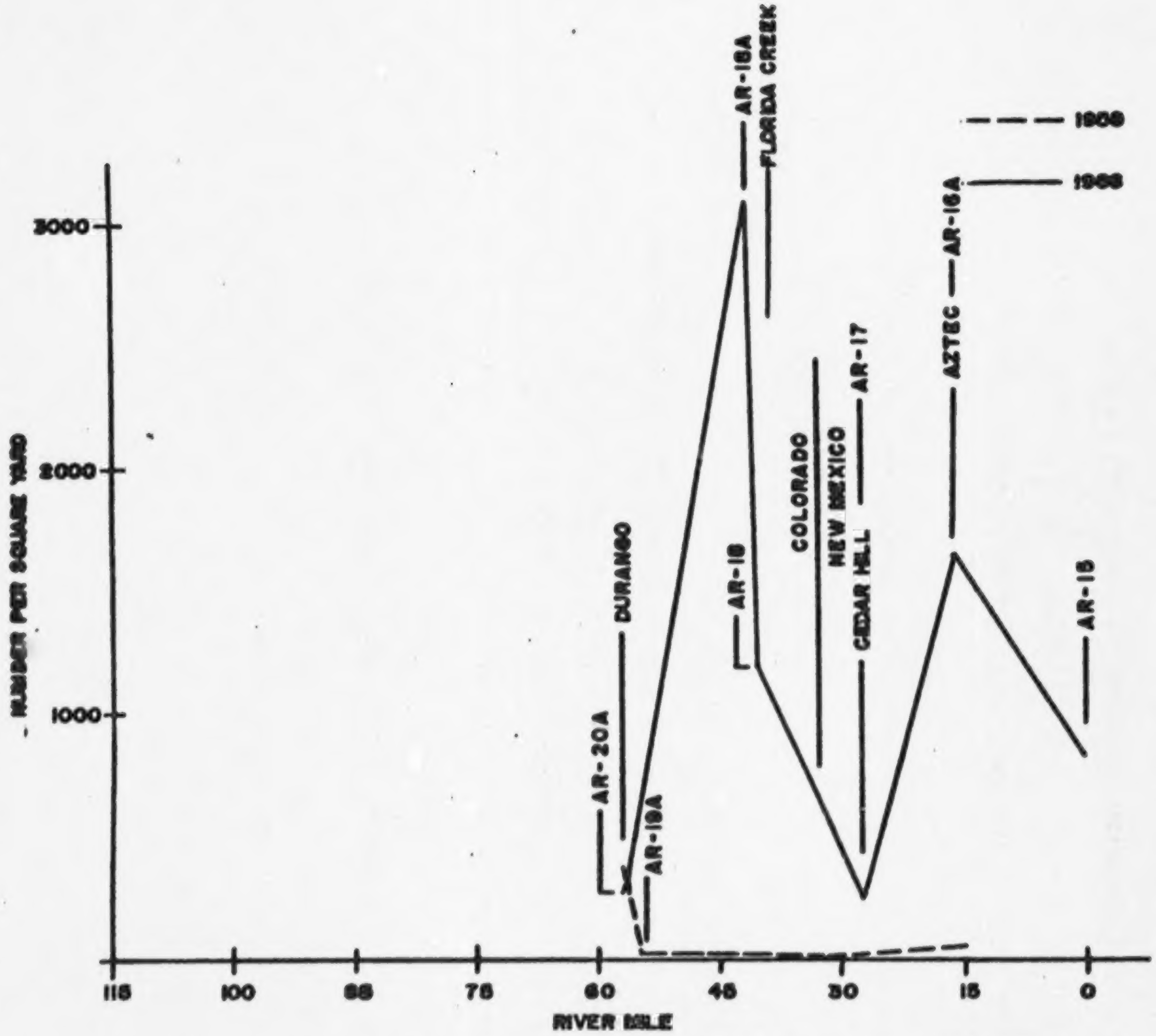

FIGURE 35. ANIMAS RIVER, NUMBER OF BOTTOM ORGANISMS PER SQUARE YARD.

(AR-17). The sharp increase downstream from Durango is a response of the bottom organisms to organic enrichment contained in the municipal wastes discharged from Durango, and shows the effects of removal of the toxic mill wastes from the Animas River. In 1961, from Durango to the Colorado-New Mexico State line, prior to the closing of the Vanadium Corporation of America mill, the Animas River did not support a trout fishery. Now this reach of river is used extensively for trout fishing, and is stocked by the State of Colorado.

The Animas River from the Colorado-New Mexico State line to its mouth at Farmington, New Mexico supported a population of bottom organisms typical of an unpolluted river. The number of kinds of organisms remained at 14 (Figure 36) while the total organisms per square foot increased from 172 at Cedar Hill (AR-17) to 606 per square foot at Farmington (AR-15). The trout fishery in the Animas River is restricted between Cedar Hill and Aztec, New Mexico because of irrigation return flows that increase water temperatures. The maximum water temperature recorded in the period July 12-23, 1966 upstream from Cedar Hill, New Mexico was 23.5°C; 12 miles downstream, at Aztec, New Mexico, the maximum water temperature was 27.0°C. The Animas River downstream from Aztec, New Mexico to Farmington supports a warm-water fishery.

The entire flow of McElmo Creek upstream from Cortez, Colorado was comprised of irrigation return flows that supported 8 kinds of

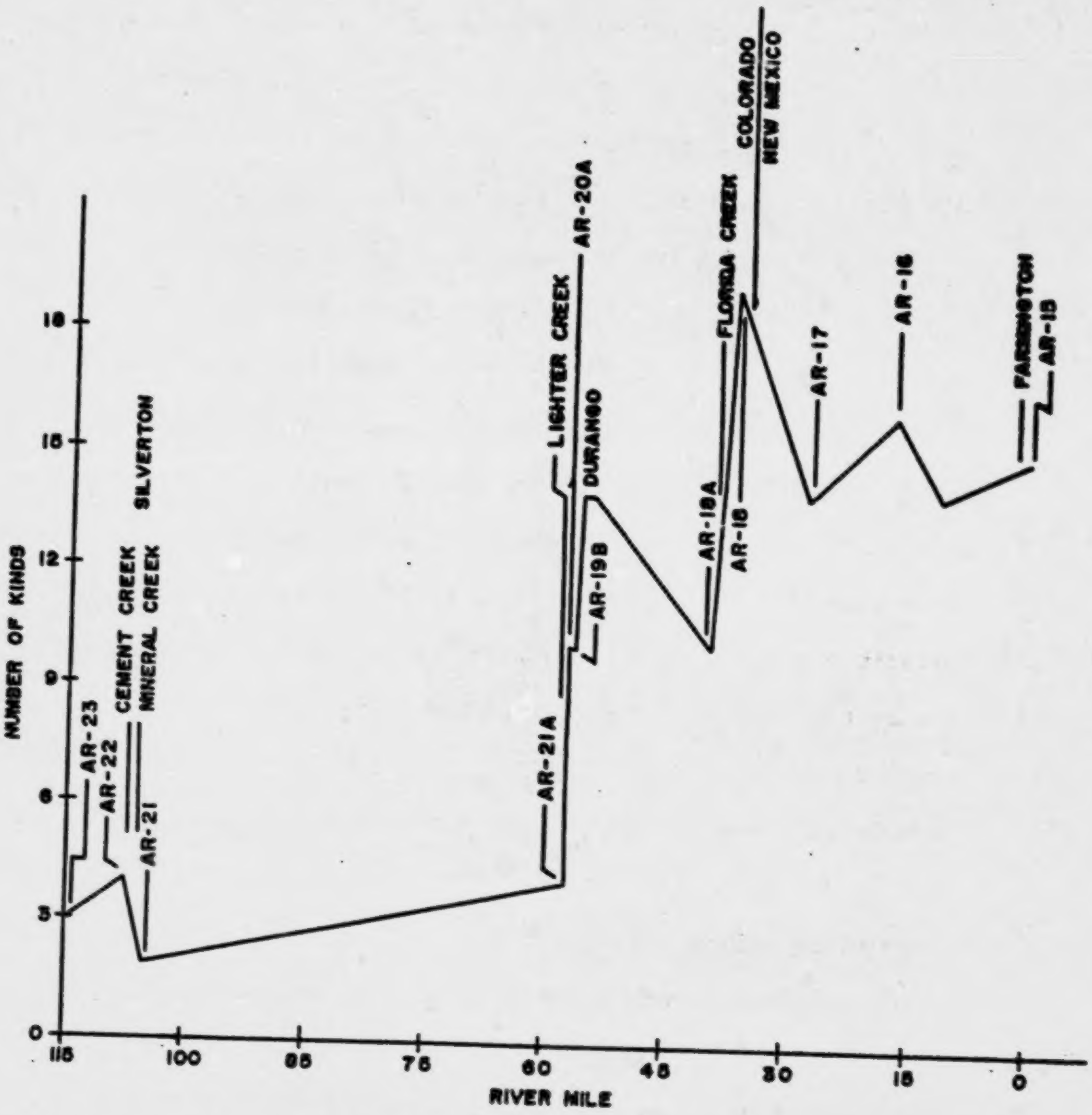

FIGURE 36. ANIMAS RIVER, NUMBER OF KINDS OF BOTTOM ORGANISMS, JULY 1966.

bottom organisms at a density of 86 per square foot (Table 29). Downstream from Cortez, the discharge from this town's sewage treatment plant provided the majority of the stream flow (Station MC-13). Pollution-tolerant sludgeworms dominated the bottom organism population at this station. With the addition of dilution water and natural purification, the aquatic life recovered 9 miles downstream (MC-12). Just upstream from its confluence with the San Juan River (MC-11), McElmo Creek supported 81 organisms per square foot (Figure 37) composed of 8 kinds (Figure 38), most of them clean-water forms.

In summary, the San Juan, Piedra, and the Los Pinos Rivers supported populations of bottom organisms and fish typical of unpolluted rivers. Downstream from Navajo Lake on the San Juan River, the trout population was replaced by warm-water fish as a result of natural warming. Mine drainage to the Animas River upstream from Silverton, Colorado, and to Cement and Mineral Creeks, rendered the Animas River unsuitable for trout for several miles downstream from Silverton, Colorado (Figure 39). The reach of the Animas River from Durango, Colorado to Cedar Hill, New Mexico had fully recovered biologically since the closing of the Vanadium Corporation of America mill at Durango. The Animas River, from Aztec to the confluence of the San Juan River is warmed by return irrigation waters, and the trout fishery is replaced by a warm water fishery. McElmo Creek, downstream from Cortez, Colorado, supported a population of pollution-tolerant organisms because the major portion of the stream was comprised of poorly treated sewage effluent from Cortez.

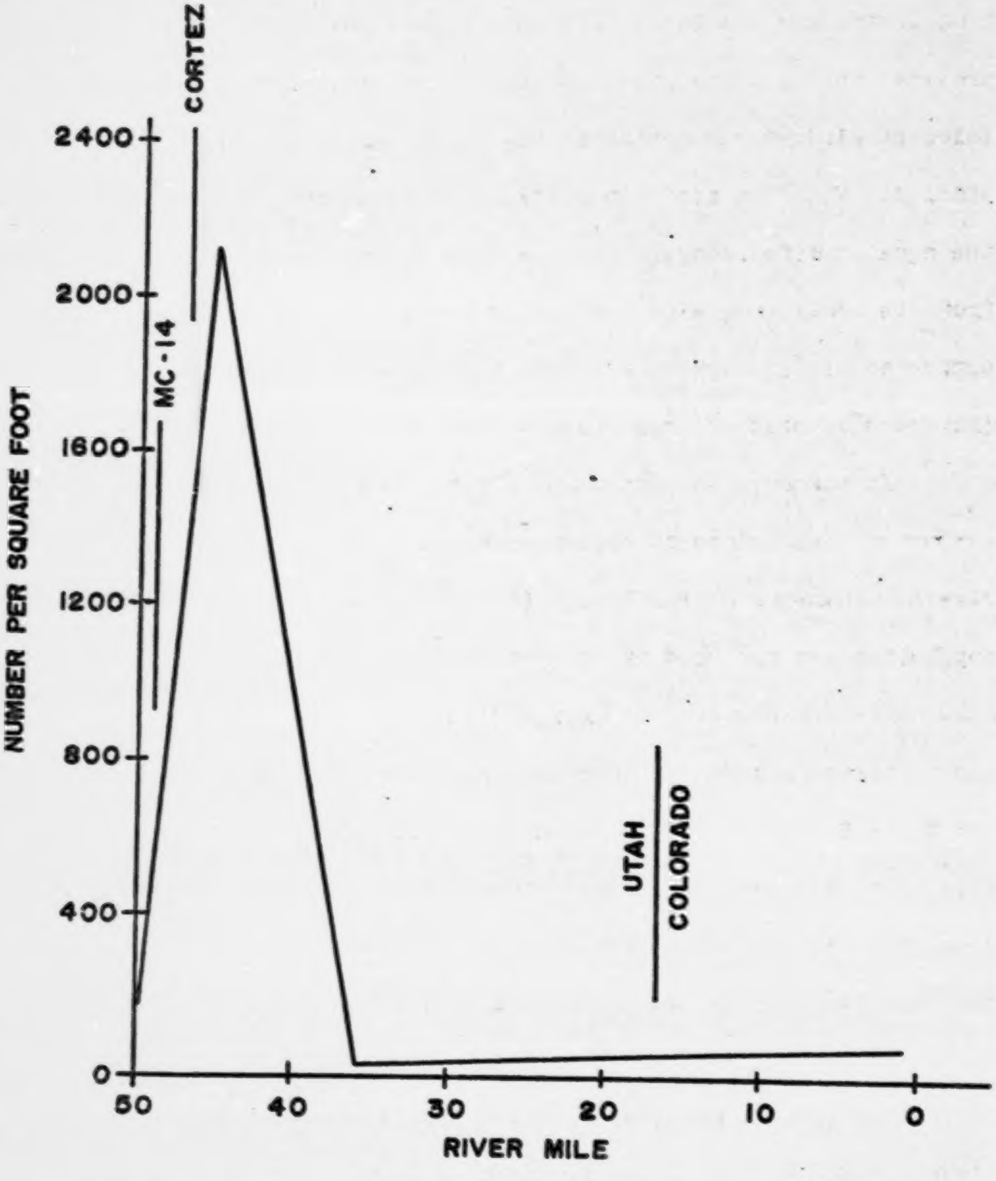

FIGURE 37. McELMO CREEK, NUMBER OF BOTTOM ORGANISMS PER SQUARE FOOT, JULY 1966

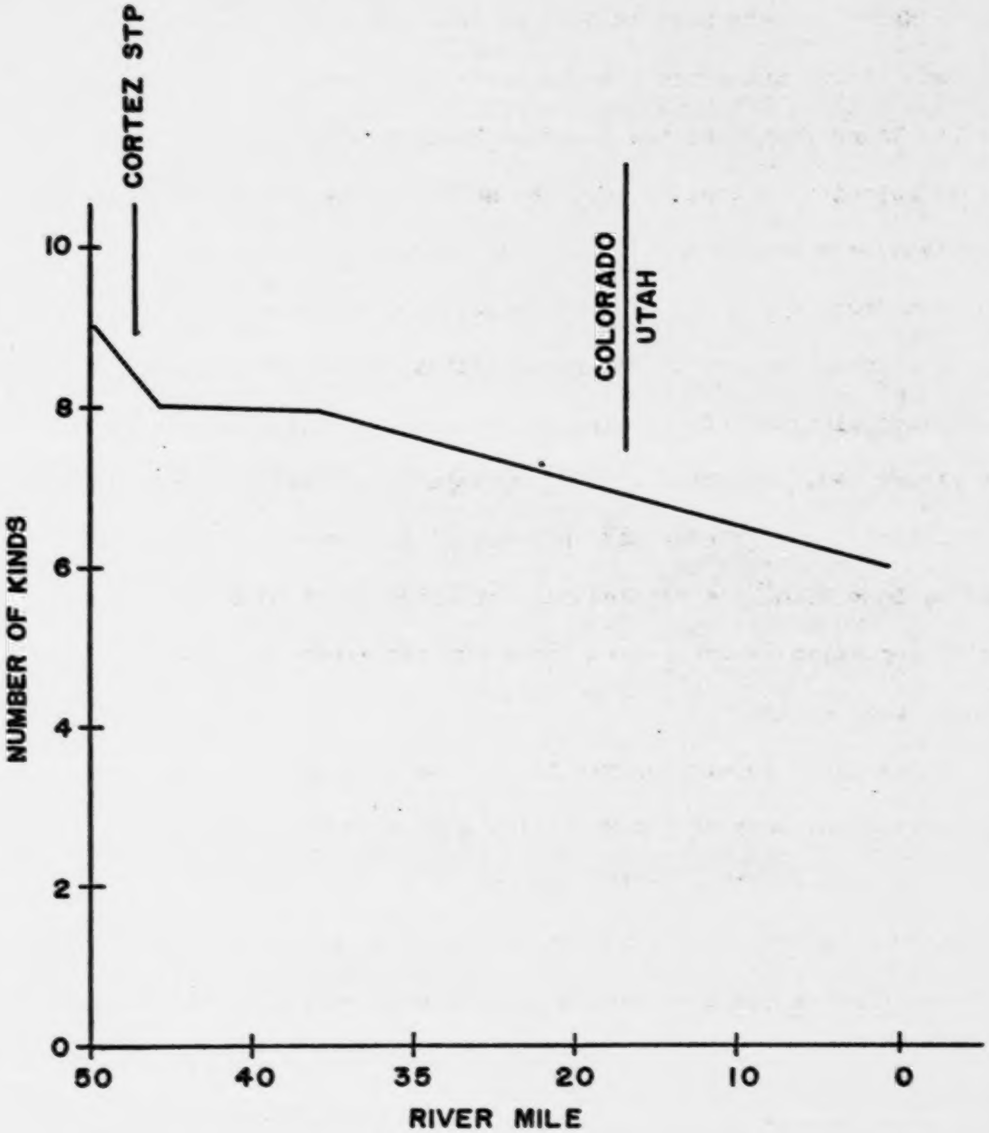

FIGURE 38. McELMO CREEK, NUMBER OF KINDS OF BOTTOM ORGANISMS, JULY 1966.

COLORADO RIVER FROM PIERCE CANYON, UTAH, TO THE MEXICAN BORDER

Pierce Canyon To Lake Mead

Water in Lake Mead is derived from one major source, the Colorado River, and three minor sources, the Muddy and Virgin Rivers and Las Vegas Wash. As the Colorado River becomes Lakes Mead, the stream velocity is checked, and the aquatic life is adversely affected by extensive deposits of silt carried in by the free-flowing stream. Upstream from Lake Mead the benthic population cannot develop because of the shifting nature of the river bottom, abrasive action of silt particles, clogging of organism gills, and the settled silt blanketing the stream bed. Benthic sampling revealed that bottom organisms were nonexistent in the Pierce Canyon reach of the Colorado River. At the head of Lake Mead, the settled silt provided an unsuitable habitat for benthic organisms which are an important and essential link in the aquatic food chain.

The algal population was limited because silt reduces light penetration and some of the particles adhere to the algal cells, thus speeding their settling to the bottom. The algal population supported by the free-flowing Colorado near its confluence with Lake Mead was 100/ml. Diatoma hemialae was the alga predominating this scant population. Algae are basic and necessary components of an aquatic food chain that culminates in fish production.

No attached algae could be found along the banks of the Colorado River upstream from Lake Mead where the water was turbid. In the upper reach (Gregg Basin) of Lake Mead, where the water had cleared, attached algae, such as *Cladophora sp.*, *Cocconeis sp.* and *Gomphonema sp.*, were collected from logs and rocks.

The nutrient contribution of the free-flowing Colorado River to Lake Mead was greatly affected by the settling of silt. In the upper reach of Lake Mead, between river miles 430 and 413.9, the soluble phosphorus (P) was reduced 66 percent (15 to 5 µg/l). The total phosphorus (P) concentration was reduced 89 percent (350 to 40 µg/l). This settled phosphorus is permanently lost from the aqueous system as a nutrient source for algae, since the phosphorus is inertly bound to the particles and not available for algal production even if the silt were resuspended.

The influent contributions of soluble phosphorus to Lake Mead during April 1966 are listed in the following tabulation.

Influent	Lbs. of Sol. P contributed/day	% Total Sol. P.	Flow cfs	% Total Flow	Sol. P µg/l
Colorado River	1,231	62	15,200	98	15
Virgin River	33	2	246	1.5	25
Muddy River	9	1	38	.3	45
Las Vegas Wash	711	35	31	.2	4,250
Total	1,984	100	15,515	100	4,335

Although the inorganic nitrogen (N) was reduced 40 percent (1.0 to 0.6 mg/l) by the settling of the silt, it did not limit the production of algae since a sufficient amount, 0.6 mg/l, remained.

There is little fishing in the turbid waters where the Colorado River becomes Lake Mead, because of the inaccessibility, and also because the fish population is predominantly small channel catfish.

Fisherman-use of the 300 mile reach of the Colorado River from Glen Canyon to Lake Mead averaged 3.5 fishermen per day in the spring and summer of 1962.* The fish catch averaged 0.8 fish per man-hour and was predominantly small channel catfish. In June 1963, the reach of river downstream from Glen Canyon Dam was stocked with trout that provided good fishing during the summer and fall months.

An estimated 350,850 anglers fished in Lake Mead during 1963.** A sampling of 960 anglers showed the average catch to be 0.66 fish per man-hour. The catch consisted mainly of largemouth bass with lesser numbers of catfish, crappie and bluegill.

In summary, the substrate of the Colorado River is unsuitable for the development of bottom organism populations because of silt and shifting sand. The low population of phytoplankton in the Colorado River is due to the action of large quantities of suspended silt. The Colorado River furnishes 62 percent of the soluble phosphorus by weight, and 98 percent of the flow to Lake Mead. A limited channel catfish fishery exists in the Colorado River upstream from Lake Mead.

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* Bassett, H. M. 1962. A creel census of streams in District II. From D-J Report No. F-7-R-5, Job C-2, Arizona Game and Fish Dept. Phoenix, Arizona.

**Wood, Norman. 1964. Arizona-Nevada Cooperative Fisheries Survey - 1963. From Minutes, Tech. Comm. of Colorado River Wildlife Management Comm. Meeting, Las Vegas, Nevada (Jan. 22, 1964).

Virgin River

The Virgin River has its origin in Zion National Park, Utah, where the stream is composed of a series of riffles and pools. At St. George, Utah, the stream bed widens and the rocks become covered with fine sand. The benthic population in this reach (R.M. 386.50/109.0) was composed of three kinds of mayfly nymphs, one kind of caddisfly larvae, one kind of black fly larvae, and sludgeworms. (Table 31). The same types or organisms collected at the St. George station were found at Littlefield, Arizona (R.M. 386.5/71). Wastes discharged to the Virgin River from St. George, Utah did not degrade the benthic population. At the last station on the Virgin River before entering Lake Mead, silt had reduced the density of the benthic organisms; however, the number of kinds of organisms remained essentially the same as at upstream stations. The only location where organisms could be found at a downstream station was a submerged brush pile at the head-end of an island. Here the velocity was at its greatest and there was little chance for silt to settle on the organisms.

Pollution from natural sources causes the degradation of the Virgin River; namely, the silt resulting from the rapid runoff over the arid, sparsely vegetated watershed. The phytoplankton population of the Virgin River at St. George was limited to 100 algae per ml by the large quantities of silt. The attached algal population consisted of a few pennate diatoms.

The total phosphorus concentration at Riverside Arizona (R.M. 386.50/48.4) in the Virgin River was high (620 µg/l) because large quantities of inorganic phosphorus were bound to the silt. The soluble phosphorus concentration, at this station however, was low (25 µg/l). The contribution of soluble phosphorus to Lake Mead from the Virgin River will remain at this low concentration since the large quantities of inertly bound phosphorus are settled and buried in bottom sediment, and cannot be changed into the soluble form. The inorganic nitrogen concentration of 0.7 mg/l would not significantly alter the nitrogen concentration in Lake Mead because the lake's concentration was already equal to or greater than this level. Wastes from St. George, Utah increased the ammonia nitrogen concentration from less than 0.1 to 0.9 mg/l. The ammonia concentration was reduced to 0.2 mg/l at Riverside, Nevada, the station farthest downstream on the Virgin River.

In summary, the Virgin River is not degraded by the activities of man, but rather as a result of rapid runoff which transports fine particle of silts to the stream. These silts reduced the population of bottom organisms from 39 per square foot, composed of 4 kinds, at Littlefield, Arizona, to a few organisms that inhabit brush piles only at Riverside, Nevada. The phytoplankton population was limited to 100 organisms per ml. The Virgin River provides 1.5 percent of the flow and 2 percent of the soluble phosphorus to Lake Mead.

Muddy River

The Muddy River empties into the Overton Arm of Lake Mead. This river originates from several large springs situated 6 miles northwest of Moapi, Nevada. The stream in the Glendale, Nevada area is composed of rocks, riffles, and sandy pools. The benthic population inhabiting the riffles was composed of 2 kinds of midges, a sludgeworm, and 2 kinds of mayflies. Wastes from Glendale, Nevada did not degrade the benthic population inhabiting the Muddy River.

The degradation of the Muddy River, like that of most rivers in the arid desert climate, is due to natural causes, namely, silt from rapid runoff. During April 1966 the Muddy River at Glendale, Nevada, (386.50/23.0/20.9) carried only a small silt load, permitting a benthic population of 218 organisms per square foot to develop in riffle areas. Mayfly nymphs of the genus *Tricorythodes sp.*, which are very resistant to even high silt concentrations, predominated the benthic population. The phytoplankton population numbered 100 algae per ml in the Glendale, Nevada area. The attached algal population on artificial substrates numbered 1,517,000 per square inch, or 100 times that of the Virgin River. The pennate diatoms, *Nitzschia* and *Connoneis*, the green alga *Basidadia*, and the coccoid group, predominated the attached algal population.

The nutrient contribution of the Muddy River to Lake Mead was insignificant in that the concentration of soluble phosphorus was

45 µg/l and the total phosphorus concentration was 300 µg/l, the major portion of it being tied up in the silt. The inorganic nitrogen concentration at the Glendale, Nevada station was 0.7 mg/l; but this also was insignificant since phosphorus appears to be the limiting element in Lake Mead.

In summary, the wastes entering the Muddy River do not degrade the water or the substrate or adversely affect the population of bottom organisms.

Las Vegas Wash

The highest number of algae in Lake Mead occurred in the immediate vicinity of the mouth of Las Vegas Wash. The highest value (39,300 algae/ml) was obtained on April 4, 1966 at the Park Service Buoy off Las Vegas marina (360.0).

Surface algal counts exceeding 9,000/ml occurred for a distance of 3 miles out from the mouth of the wash; surface counts exceeding 2,000/ml extended out 6 miles.* In the main body of Lake Mead the surface counts were less than 2,000/ml. The principal alga in the

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*The studies of Las Vegas Bay have been reported in separate reports:

Anon. 1965. Algal and Nutrient Survey of the Surface Waters of Lake Mead-June 4-8, 1965. U. S. Public Health Service, Robert A. Taft SAnitary Engineering Center, Cincinnati, Ohio, pp 8. (Mimeo)

Anon 1966. Report on the Pollution in Las Vegas Wash and Las Vegas Bay. Dept. of Interior, Federal Water Pollution Control Administration, Cincinnati, Ohio, pp 25 (Mimeo)

9,000/ml area was *Oscillatoria sp.* which, in many cases, comprised 50 percent of the total phytoplankton population. The arm of Lake Mead into which Las Vegas Wash empties was the only area that exhibited surface algal concentrations 5 times greater than the surface algal concentration observed in the main body of Lake Mead.

At Station SI-1 (near the Henderson and Las Vegas water supply intake) surface algae numbered 1,600/ml, but contained *Asterionella formosa* and *Fragillaria sp.* Both of these species will clog filters and shorten filter runs in water treatment plants. Two miles upstream from the Boulder City water treatment intake, the surface algal count was 900/ml and contained taste-and-odor-causing algae, such as Oocystis sp. and 50/ml each of *Asterionella formosa* and *Fragillaria sp.*

Analytical results indicate that Lake Mead, except in Las Vegas Bay, was phosphorus deficient in relation to those threshold limits that have been associated elsewhere in other lakes with algal blooms that interfere with various water usages. The surface portion of the main body of Lake Mead contained a total phosphorus (P) concentration of 5 µg/l and no soluble P, whereas the 6-mile area out from the Las Vegas Wash contained a concentration of 24 µg/l total P and 10 µg/l soluble P.

The surface inorganic nitrogen does not appear to be a limiting fertility factor for phytoplankton production in Lake Mead because concentrations exceeding 0.3 mg/l occurred in the center of the area containing less than 2,000 algae per ml. The total organic nitrogen exceeded 0.5 mg/l in surface water at many sampling stations in the study area, indicating there was a large supply of nitrogen available for the development of nuisance algal populations if sufficient phosphorus were present.

In summary, nutrients entering Lake Mead from the Las Vegas Wash were sufficient in quantity to produce surface algal concentrations exceeding 39,300 ml in the immediate vicinity of the mouth of the wash. Algal concentrations in the lake decreased with distance from the mouth of the wash. Algal populations near the Henderson-Las Vegas water supply intake and the Boulder City intake were characteristic of Lake Mead surface waters and were not influenced by the algal populations produced by the nutrients discharged from the Las Vegas Wash.

Lake Mead

Lake Mead received 1,984 pounds per day of soluble phosphorus from four inflows during the April 1966 survey: (1) 62 percent or 1,231 pounds per day was contributed by the Colorado River; (2) 35 percent or 711 pounds per day by the Las Vegas Wash; (3) 2 percent or 33 pounds per day by the Virgin River; and (4) 1 percent or 9 pounds per day from the Muddy River. The flow in the Colorado River was 15,200 cfs and the Las Vegas Wash contributed 31 cfs.

Previous studies, Anon (1965) of Lake Mead showed the only area exhibiting any increase in algae and nutrients above the open water of Lake Mead to be Las Vegas Wash arm.

The contribution of soluble phosphorus by the Las Vegas sewage treatment plants was the most significant source of nutrient pollution resulting from man's activities in the Lower Basin.

Havasu Lake - Metropolitan Water Intake

Phytoplankton populations in Lake Havasu at the metropolitan water intake (R.M. 200:65) numbered 350 algae per ml. The predominant alga was *Dinobryon sp.* This alga is known to cause filter clogging, but at the low numbers observed, problems are not likely to arise.

On the floor of the intake structure for the pumping station, Asiatic clams, *Corbicula fluminea*, were observed. Asiatic clams have occurred in this system for several years and have purportedly caused hydraulic problems in the transmission of Colorado River water to California.

There were no significant pollution sources observed in this reach of the Colorado River that had an adverse effect on the aquatic life.

Colorado River- Parker Dam to Parker, Arizona

The reach of the Colorado River from Parker Dam to Parker, Arizona is used extensively for recreation. The benthic population in this reach, as in most of the Colorado River, was limited. It was comprised of midges, sludgeworms, Asiatic clams, mayfly nymphs and beetle larvae. The predominant organism in this reach was the Asiatic clam which numbered 15 per square foot. No effect from the intense recreational use on the benthic population could be observed in this reach.

The phytoplankton population near Parker Dam (R.M. 198:10) numbered 300 algae per ml with Dinobryon sp. predominating. At the lower end of this reach (R.M. 182.5) the algal population numbered 400 per ml and flagellated green algae predominated. An increase of the above magnitude in the phytoplankton population and the change in species were not significant because the density remained low. As a result of the intense recreational activity on this reach of river, the total phosphorus concentration increased from less than 5 µg/l to 10 µg/l. The soluble phosphorus remained at the same concentration (less than 5 µg/l), indicating that the available phosphorus was immediately incorporated into algal growth. The inorganic nitrogen concentration (0.7 mg/l) remained constant from Parker Dam to Parker, Arizona.

The fish population between Parker Dam and Parker, Arizona was composed of warm-water species such as catfish, largemouth black bass, sunfish and carp. A creel census conducted by personnel of the California Fish and Game Department found a poor catch rate of 0.16

fish per hour between October and December 1962.* Even so, the river bank was lined with fishing camps during the 1966 survey.

In summary, wastes from the intense recreational activity in the stream reach from Parker Dam to Parker, Arizona did not adversely affect the population of bottom organisms. The slight increase in phosphorus did not cause a significant change in the algal population.

Colorado River Indian Reservation

The inlet channel for the Colorado River Indian Reservation irrigation system is located 2 miles upstream from Parker, Arizona. The population of bottom organisms inhabiting this channel was comprised of midges, black flies, sludgeworms and Asiatic clams. Predominant in this population was the Asiatic clam which numbered 197 per square foot (R.M. 184.0). The bottom substrate in the inlet channel was comprised of fine gravel, fine sand, and silt.

The irrigation return canal, 11 miles (R.M. 139.6) upstream from Blythe, California supported a mixed population of bottom organisms predominated by midges and Asiatic clams. The Asiatic clam population, however, was reduced in the irrigation return canal to 5 per square foot. The substrate of the return canal was comprised of silt. The change in the population of bottom organisms in the irrigation system was a result of a change in stream habitat and flow velocity rather than a direct degradation of water quality by irrigation return flows.

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*Soule, Scott. 1963. Summary of California Fishery Activities Along the Colorado River for 1962. From Minutes, Tech. Comm. of the Colorado River Wildlife Nat. Comm. Meeting, Davis Camp, Arizona

The phytoplankton population in the inlet channel was similar to that found in the Colorado River. The algae numbered 50 per ml and were predominatly flagellated green algae. The attached algal population numbered 1,262,500 per square inch and was predominantly pennate diatoms; on a few of the rocks along the canal bank, short strings of Cladophora sp. were found.

In the secondary return canal (139.6/1.6) the phytoplankton population had increased to 2,700 algal cells per ml and was composed primarily of coccoid green algae. In a main return canal, flagellated green algae numbered 200 per ml. The attached algal population numbered 992,700 per square inch in the secondary return canal approximately the same as in the inlet canal. The centric diatom Bidduephia laevis predominated volumetrically, while the pennate diatoms predominated numerically.

The soluble phosphorus concentration in the return canal was 27 µg/l compared to < 5 µg/l in the inlet canal; the total phosphorus concentration increased from 10 to 41 µg/l. These increases in the total and soluble phosphorus are attributed to agricultural practices. The Colorado River Indian Reservation irrigation system returned 1.2 pounds of soluble phosphorus per day to the Colorado River at the time of the survey. Whereas the inorganic nitrogen concentrations remained relatively unchanged, with 0.7 mg/l entering and 0.3 mg/l leaving the irrigation system.

In summary, bottom organism populations in the Colorado River Indian Reservation irrigation system were adversely affected by increased quantities of silt and decreased stream velocities. The phytoplankton population increased, but not to the extent that they interfered with water usage in the Colorado River. The soluble and total phosphorus concentrations increased 5-fold and 4-fold, respectively, but neither was present in sufficient quantity to increase the plankton population in the Colorado River. The inorganic nitrogen concentration remained approximately the same.

Palo Verde Irrigation System

The inlet canal of the Palo Verde irrigation system is situated about 1 mile upstream (R.M. 140.2) from the outlet drain of the Indian Reservation irrigation district. The population of bottom organisms inhabiting the inlet canal was composed of mayfly nymphs, caddisfly larvae, and Asiatic clams. This clean water population, as described, provided food for a game fish population. The substrate of the inlet canal was composed of silt and rock. Three miles downstream from the town of Palo Verde the irrigation return drain empties into the Colorado River (R.M. 101.5). The population of bottom organisms in the return drain was composed of the same types of organisms as were found in the inlet canal. The phytoplankton population of the inlet canal numbered 200 per ml with a yellow-green alga Dinobryon sp. predominating. The attached algal population numbered 274,400 per square inch with Diatoma sp. predominating. In the return drain the phytoplankton population numbered 600/ml (R.M. 101.5/2.0). A similar increase was noted in the attached algal community. The attached algal population increased to 4,943,000 per square inch and the predominant alga was Achnanthes sp.

Use of Colorado River water for irrigation in the Palo Verde irrigation system increased the soluble phosphorus from 5 µg/l in the inlet canal to 11 µg/l in the outlet canal. Total phosphorus increased from 20 to 93 µg/l. The concentration of inorganic nitrogen remained at the same level

The Palo Verde irrigation system returned 31 pounds of soluble phosphorus per day to the Colorado River. No detectable increase in pesticides could be found in the return drain for the chemicals tested.

In summary, the population of bottom organisms in the return drain contained the same types of animals as found in the inlet canal. The phytoplankton population increased 2.5 times while the attached algal population increased 20-fold. This increase resulted from the addition of nutrients to the irrigation system. The soluble and total phosphorus concentrations increased 2.5-fold and 5-fold, respectively. No significant change was observed in the concentration of inorganic nitrogen.

Imperial Dam to Laguna Dam

The productivity of aquatic life was greatly increased in the reach of river from Imperial Dam to Laguna Dam. The population of bottom organisms in the Imperial Dam area (R.M. 50.0) was composed of midges and Asiatic clams. The population of bottom organisms downstream from Laguna Dam (R.M. 44.0) comprised 12 types of organisms, including midges, Asiatic clams, caddisflies, black flies, mayflies, and beetle larvae. This increase in bottom organisms resulted from an increased food supply. The phytoplankton population increased from 800 algae per ml at Imperial Dam to 2,600 per ml at Laguna Dam, as a result of an increase in major nutrients. Soluble phosphorus concentrations averaged 17 and 10 µg/l respectively at Imperial and Laguna Dams. The total phosphorus concentration decreased from 35 to 27 µg/l.

In summary, the increase in the population of bottom organisms observed in the Laguna Dam area resulted from an increase in nutrients. This in turn increased the algal population and provided more food for the bottom organisms.

Yuma, Arizona to Morelos Dam

Upstream from Yuma's raw sewage discharge the population of bottom organisms numbered 142 per square foot, with 5 kinds present. Caddisfly larvae predominated. The bottom substrate in this reach was fine sand. Fifty feet downstream from the sewage discharge

(R.M. 27.0) only midges and sludgeworms inhabited the stream bed. These pollution-tolerant organisms were feeding on the organic sludge mixed with the fine clay substrate. About 5.5 miles downstream from the sewer outfall, the Colorado River had assimilated the raw sewage wastes sufficiently to permit the development of a mixed population of benthic organisms. At this station (R.M. 21.3) the population of bottom organisms was composed of 9 types with a density of 87 per square foot. The increase in the number of kinds was in the midge group which are intermediately pollution-tolerant animals.

The phytoplankton population in this reach of the Colorado River remained unaltered by the discharge of sewage from Yuma, Arizona. The phytoplankton population was predominantly coccoid greens and numbered 3,800/ml. Downstream from the sewage treatment plant, the soluble phosphorus concentration was unchanged, 25 µg/l; however, the total phosphorus increased from 63 to 138 µg/l.

Of the 20 pesticides for which water samples were analyzed, only trace quantities (less than 1 µg/l) of some were detected in the water samples collected in the Yuma area. Presence of the other pesticides was not indicated.

The fishery between Imperial Dam and Morelos was severely limited by the large quantities of silt resulting from runoff and the desilting operation at the All-American canal. There is no recreational development of the river in this reach. A few fishermen utilize the river near Yuma, Arizona with catches consisting mainly of catfish, mullet, and carp.

In summary, raw sewage from Yuma adversely affects the population of bottom organisms downstream for approximately 2 miles (Figure 40). The phytoplankton population was not affected by the wastes discharged because of high stream velocities. The soluble phosphorus concentration was not increased, but the total phosphorus increased 4-fold. The inorganic nitrogen concentration remained unchanged. The fishery in this reach is limited by the large quantities of silt entering the river in the reach near Imperial Dam.

TECHNICAL APPENDIX

Table 1

Tenmile Creek Sampling Stations

STATION NUMBER	STATION DESCRIPTION
T-1	Clinton Gulch-at its diversion for the water supply of Climax Molybdenum Plant. It would normally enter the Tenmile Creek one mile downstream from Searle Creek confluence.
T-2	Kokomo Creek-at its diversion. It would normally enter Searle Creek just upstream from the abandoned town of Kokomo.
T-3	Searle Creek-upstream from its diversion. It enters Tenmile Creek 4 miles downstream from Climax.
T-4	Searle Creek-50 yards upstream from its confluence with Tenmile Creek.
T-5	Tenmile Creek-100 yards downstream from Climax molybdenum ponds and one-quarter mile upstream from Searle Creek.
T-6	Tenmile Creek-two miles downstream from Searle Creek near Mayflower Gulch.
T-7	Tenmile Creek-4 1/2 miles downstream from Searle Creek and 3 1/2 miles upstream from Wes Tenmile Creek.
T-8	Tenmile Creek-1,000 yards upstream from West Tenmile Creek.
T-9	1,000 yards downstream from West Tenmile Creek.
T-10	Tenmile Creek-half way between West Tenmile and Frisco, Colorado, near Officers Gulch.
T-11	Tenmile Creek-just upstream of Frisco, Colorado.
T-12	Tenmile Creek-1,000 yards upstream from Dillion Reservoir.
T-13	West Tenmile Creek-200 yards upstream from its confluence with Tenmile Creek.

TABLE 2

TEN MILE CREEK

Bottom Fauna Data - No. Per Sq. Ft.

October 1966

	T-1	T-6	T-3	T-2	T-4	T-5	T-12	T-11	T-10	T-9	T-13	T-7	T-8
Stoneflies													
Nemoura sp.	8	-	1	40	-	-	4	-	1	-	5	-	-
Isogenus sp.	2	-	-	-	-	-	-	4	-	-	-	-	-
Brachyptera sp.	5	-	-	8	-	-	4	4	-	-	15	-	-
Isoperla sp.	5	-	4	6	-	-	7	-	-	-	7	-	-
Perlinella sp.	-	-	1	-	-	-	-	-	-	-	-	-	-
Pteronarcys	-	-	-	-	-	-	1	-	-	-	-	-	-
Mayflies													
Rhithrogena sp.	48	-	1	-	-	-	5	1	-	-	7	-	-
Pseudocloeon sp.	3	-	2	8	-	-	2	-	-	-	4	-	-
Ephemerella sp.	1	-	-	-	-	-	1	-	-	-	30	-	-
Tricorythodes sp.	1	-	-	-	-	-	-	-	-	-	-	-	-
Cinygmula sp.	19	-	2	-	-	-	-	-	-	-	100	-	-
Ameletus sp.	-	-	25	-	-	-	-	-	-	-	-	-	-
Baetis sp.	-	-	-	-	-	-	1	1	-	-	2	-	-
Caddisflies													
Polycentropus sp.	-	-	-	18	-	-	-	-	-	-	12	-	-
Psychomyia sp.	-	-	-	-	-	-	1	-	-	-	-	-	-
Arctopsyche sp.	-	-	-	-	-	-	22	9	5	-	9	-	-
Glossosoma sp.	-	-	-	-	-	-	-	-	-	-	1	-	-
Brachycentrus sp.	-	-	-	-	-	-	-	-	-	-	3	-	-
Beetles													
Heterlimnius sp.	-	-	5	2	-	-	-	-	-	1	9	-	-
Optioservus sp.	-	-	-	-	-	-	-	-	-	-	5	-	-
Midges													
Pseudochironomus sp.	1	-	40	-	-	-	-	-	-	-	10	-	-
Brillia sp.	-	4	12	10	-	-	-	-	1	-	6	-	-
Spaniotoma sp.	-	-	3	50	-	*	10	3	1	-	31	-	-
Cricotopus sp.	-	-	-	-	-	-	-	-	-	-	7	-	-
Psychodidae	-	-	-	-	-	-	-	-	-	-	2	-	-
Tipulidae	-	-	-	-	-	-	-	-	-	-	3	-	-
Biting Midges													
Bezzia sp.	-	-	3	2	-	-	-	-	-	-	1	-	-
Empididae	-	-	-	2	-	-	-	-	-	-	-	-	-
Planarians	-	-	-	-	-	-	-	-	-	-	4	-	-
Nematodes	-	-	-	-	-	-	-	-	-	-	1	-	-
Sludgeworms	-	-	33	-	-	-	-	-	-	-	11	-	-
Number of Kinds	10	1	13	10	0	1	11	6	4	1	24	0	0
Number Per Sq. Ft.	93	4	132	146	0		58	22	8	1	285	0	0

* Collected in Qualitative Sample Only

CHEMICAL DATA - mg/l

	T-1	T-6	T-3	T-2	T-4	T-5	T-12	T-11	T-10	T-9	T-13	T-7	T-8
Total Iron	< 0.2	< 0.2	< 0.2	< 0.2	1.1	0.6	< 0.2	0.3	0.2	< 0.2	< 0.2	0.2	< 0.2
Chromium	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.02	0.02	0.02	< 0.02	< 0.02	0.02
Manganese	< 0.1	0.4	< 0.1	< 0.1	1.4	2.4	< 0.1	< 0.1	0.1	< 0.1	< 0.1	0.2	0.1
Zinc	< 0.02	1.8	0.04	0.12	6.8	1.2	0.17	0.20	0.25	0.24	< 0.02	0.6	0.38
Copper	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Molybdenum	< 0.5	< 0.5	< 0.5	< 0.5	< 0.05	5.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Lead	< 0.01	< 0.01	0.01	0.01	-	0.02	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01

TABLE 3

Eagle River Sampling Stations

Station Number-River Mileage	Station Description
57.7-0.5	Eastfork of Eagle River 0.5 Mile Upstream of Confluence.
57.7-10	West Fork of Eagle River 1 Mile Upstream from Confluence.
50	Eagle River 0.5 Mile Upstream of Redcliff, Colorado.
49.9-0.1	Turkey Cr. one-tenth Mile Upstream of Confluence with Eagle.
49.5	Eagle River 0.2 Mile Upstream of the Confluence with Homestake Cr.
49.3-1.0	Homestake Creek One Mile Upstream from Confluence with Eagle River.
48	Eagle River 0.5 Mile Upstream from Belden.
47.5	Eagle River at Gelman Upstream of Tailings Piles.
46.5 lf	Eagle River (left bank) at Discharge of old New Jersey Tailings Ponds. Not influenced by discharge.
46.5 rt	Eagle River (right bank) at Discharge of Old New Jersey Tailings Ponds. Influenced by Discharge.
44.2	Eagle River Upstream from Spring Effluent of New Jersey Zinc Tailings Ponds.
43.8-0.2	Cross Creek 0.2 Mile Upstream from Eagle River.

TABLE 3

Eagle River Sampling Stations (Con't.)

Station Number-River Mileage	Station Description
43.8-4.0	Cross Creek 0.5 Mile Upstream from New Jersey Zinc Tailings Pond Effluents.
42.5	Eagle River One Mile Upstream of Minturn, Colorado.
40.1	Eagle River 1.5 Miles Downstream of Minturn, Colorado, One Mile Upstream of Gore Creek Confluence.
39.9-4	Gore Creek One Mile Upstream of Vail, Colorado.
39.9-1.0	Gore Creek One Mile Upstream of Confluence with Eagle River.
13.1	Eagle River 0.5 Mile Upstream of Eagle, Colorado.
11.9	Eagle River One Mile Downstream of Eagle, Colorado.
6.8	Eagle River 1.0 Mile Downstream of Gypsum, Colorado.
0.2	Eagle River 0.2 Mile Upstream from the Confluence with the Colorado.
46.5-0.1	Effluent from Old New Jersey Zinc Ponds.
44.1-0.2	Spring Drain from New New Jersey Zinc Ponds.
43.8-3.0-0.1	Effluent from New New Jersey Zinc Ponds to Gross Creek.

TABLE 4 - EAGLE RIVER

Bottom Fauna Data - No. Per Sq. Ft.

October 1966

1217.4-0.2	57.7-0.5	57.7-1.0	50	49.9-0.1	49.5	49.3-1.0	48	47.5	46.5 Lf	46.5 Rt	44.2	43.8-0.2	43.8-4.0	42.5	40.1
Stoneflies															
Brachyptera sp.	8	1	7	20	8	17	2	11	-	-	-	-	4	4	7
Isoperla sp.	-	3	-	24	7	12	1	-	4	-	-	-	2	4	4
Pteronarcella sp.	-	-	1	-	3	16	-	15	4	-	2	-	-	-	11
Nemoura sp.	-	-	-	8	1	2	-	-	-	-	-	-	6	-	-
Mayflies															
Ephemerella sp.	60	10	33	50	141	114	22	11	16	-	-	1	44	-	6
Heptagenia sp.	8	3	1	5	-	2	-	-	-	-	-	-	12	-	-
Baetis sp.	-	7	26	45	11	-	2	-	-	-	-	-	2	-	1
Pseudocloeon sp.	-	-	6	37	2	-	2	-	-	-	-	-	2	-	-
Rhithrogena sp.	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Paraleptophlebia sp.	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Caddisflies															
Psychomyia sp.	4	1	-	-	20	-	1	-	-		-	-	-	-	-
Arctopsyche sp.	4	3	100	3	9	37	15	3	8		1	2	6	22	12
Brachycentrus sp.	12	-	21	88	11	17	4	3	14		-	-	14	-	1
Polycentropus sp.	4	-	-	-	-	-	-	-	-		-	-	-	-	-
Glossosoma sp.	-	-	10	-	72	1	-	-	2		-	3	38	-	1
Hydropsyche sp.	-	-	-	-	-	-	-	-	-		-	-	-	-	-
Beetles															
Heterlimnius sp.	12	18	26	8	19	1	1	-	4	NONE	-	3	-	-	6
Optioservus sp.	-	5	-	4	-	-	-	-	-		-	2	-	-	-
Cylloepus sp.	-	-	-	-	-	-	-	-	-		-	-	-	-	2
Midges															
Spaniotoma sp.	4	6	2	19	56	5	80	30	4		-	-	-	4	80
Pseudochironomus sp.	-	4	-	-	-	-	-	-	-		-	-	18	-	-
Pentaneura sp.	-	-	6	-	5	2	-	-	2		-	1	-	-	-
Cricotopus sp.	-	-	-	-	-	-	28	-	2		-	-	-	-	16
Atherix sp.	-	-	-	-	-	-	-	1	-		-	Algae	-	-	-
Tipulidae	-	-	-	8	17	-	5	1	-		-		2	-	5
Biting Midges															
Palpomyia sp.	8	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Psychodidae	8	-	1	1	1	-	-	-	-	-	-	-	-	-	-
Empididae	-	1	1	2	2	-	-	-	2	-	-	2	-	-	-
Planarians	-	-	-	-	1	-	5	-	-	-	-	-	-	-	-
Nematodes	-	2	-	1	1	-	4	-	-	-	-	-	-	-	1
Sludgeworms	-	2	-	-	-	36	30	2	4	-	-	-	6	-	-
Number of Kinds	11	14	14	16	19	14	15	9	13	0	2	8	14	4	14
Number Per Sq. Ft.	132	66	241	323	387	264	202	77	70	0	3	15	158	34	153
CHEMICAL DATA - mg/l															
Total Iron	<0.2	0.6	0.2		<0.2	0.5	0.5	0.4	4.3	38.4	1.6	1.0	0.2	1.4	0.9
Chromium	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese	<0.1	<0.1	<0.1		<0.1	<0.1	0.1	<0.1	0.2	10.6	1.1	4.3	<0.1	2.0	1.6
Zinc	<0.02	<0.02	<0.02		<0.02	<0.02	0.13	0.02	0.15	4.1	0.31	1.7	<0.02	0.58	0.57
Copper	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02	0.10	<0.02	<0.02	<0.02	<0.02	<0.02
Molybdenum	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	0.02	0.01	<0.01		0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.01	<0.01	<0.01

TABLE 4 - EAGLE RIVER

Bottom Fauna Data - No. Per Sq. Ft.

October 1966

	39.9-4	39.9-1.0	13.1	11.9	6.8	0.2	46.5-0.1	44.1-0.2	43.8-3.0-0.1
Stoneflies									
Pteronarcys sp.	-	-	-	-	1	-			
Pteronarcella sp.	-	9	7	96	2	-			
Brachyptera sp.	4	5	3	-	1	3			
Isoperla sp.	-	7	-	32	-	-			
Mayflies									
Heptagenia sp.	1	1	3	-	4	6			
Rhithrogena sp.	14	2	4	-	1	8			
Ephemerella sp.	26	25	-	8	4	-			
Baetis sp.	2	1	-	-	-	-			
Pseudocloeon sp.	-	-	-	-	-	2			
Caddisflies									
Heliopsyche sp.	-	-	-	-	6	1			
Glossosoma sp.	-	79	29	24	129	-			
Brachycentrus sp.	20	185	141	256	243	26			
Hydropsyche sp.	-	-	13	128	31	170			
Cheumatopsyche sp.	-	-	-	-	7	162			
Arctopsyche sp.	4	37	3	-	-	-			
Agraylea sp.	-	-	-	-	-	5			
Psychomyia sp.	-	2	-	-	-	-			
Beetles									
Heterlimnium sp.	-	3	5	640	10	-			
Optioservus sp.	-	-	-	560	9	-			
Blackflies									
Prosimulium sp.	-	-	-	-	-	1			
Midges									
Microtendipes sp.	-	-	-	-	4	-			
Spaniotoma sp.	4	10	1	88	-	3			
Cricotopus sp.	-	3	-	-	-	-			
Tipulidae	-	11	2	1	-	1			
Atherix sp.	-	-	3	2	1	2			
Blepharoceridae	-	4	-	-	-	-			
Sludgeworms	-	2	-	-	-	-			
No. of Kinds	8	17	12	11	15	13			
Number Per Sq. Ft.	75	385	214	1835	453	390			
CHEMICAL DATA - mg/l									
Total Iron	<0.2	<0.2	0.2	0.3	0.3	0.5	2700	60.0	1.1
Chromium	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.04	<0.02	<0.02
Manganese	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	880	310	14.0
Zinc	<0.02	<0.02	0.04	0.03	0.04	0.03	240	26.0	6.0
Copper	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1.1	0.18	0.06
Molybdenum	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.02	-

TABLE 5

Roaring Fork Sampling Stations

Station Number - Mileage	Station Description
1199-48	Roaring Fork River 0.1 Mile Upstream of Aspen, Colorado.
45	Roaring Fork River 0.3 Mile Upstream of Aspen Sewage Treatment Plant.
44	Roaring Fork River 0.7 Mile Downstream from Aspen Sewage Treatment Plant.
43-1.2	Hunter Creek 0.2 Mile Downstream from the Aspen Consolidated Mining Co.
43-1.0	Hunter Creek 0.4 Mile Downstream from the Aspen Consolidated Mining Co.
43-2.0	Hunter Creek 0.8 Mile Upstream from the Aspen Consolidated Mining Co.
42.1	Roaring Fork River 0.9 Mile Downstream from the Confluence with Hunter Creek.
40	Roaring Fork River across from Aspen Meadows.
38 lf & rt	Roaring Fork River at Woody Creek Road Downstream of Wood Creek, Colorado.

TABLE 6

ROARING FORK RIVER

Bottom Fauna Data - No. Per Sq. Ft.

October 1966

	1199-48	1199-45	1199-44	1199-43-1.2 Fast Water	1199-43-1.0 Pool	1199-43-2.0	1199-42.1	1199-40	1199-36 Left Bk.	1199-36 Rt. Bk.
Stoneflies										
Perlesta placida	1	1	-	-	-	-	-	-	-	-
Brachyptera sp.	-	2	-	-	-	-	-	-	-	2
Nemoura sp.	-	-	-	2	-	2	-	-	-	-
Isoperla sp.	-	-	12	-	-	3	-	-	-	-
Pteronarcella sp.	-	-	6	-	-	-	-	-	1	2
Mayflies										
Heptagenia sp.	1	-	-	43	-	-	-	-	-	-
Rhithrogena sp.	1	3	-	33	-	7	-	-	-	2
Ephemerella sp.	2[illegible]	37	2[illegible]	-	4	3	-	-	-	4
Baetis sp.	1	2	-	-	-	1	-	6	5	11
Paraleptophlebia sp.	-	-	-	-	8	-	-	-	-	-
Pseudocloeon sp.	-	-	4	-	-	1	1	26	7	2
Caddisflies										
Leptocella sp.	3	1	16	-	-	1	-	1	6	2
Glossosoma sp.	31	104	20	3	-	9	-	-	-	-
Arctopsyche sp.	1	20	-	16	-	4	-	11	5	6
Brachycentrus sp.	136	89	44	8	-	11	-	-	2	-
Psychomyia sp.	-	4	-	18	1	1	-	-	-	-
Polycentropus sp.	-	2	-	-	-	-	-	-	-	-
Cheumatopsyche sp.	-	1	-	-	-	-	-	-	-	-
Beetles										
Optioservus sp.	-	9	20	8	8	4	2	-	-	2
Zaitzevia sp.	-	-	4	-	1	-	-	-	-	-
Heterlimnius sp.	-	4	-	6	-	-	-	-	1	-
True Flies										
Blackflies										
Prosimulium sp.	-	-	-	-	-	-	-	-	-	3
Midges										
Pentaneura sp.	2	-	48	-	-	-	-	-	-	-
Pseudochironomus sp.	15	-	-	-	2	-	-	-	-	-
Spaniotoma sp.	-	5	2[illegible]0	2	4	-	30	20	106	5
Polypedilum sp.	-	-	-	-	-	-	10	-	-	-
Cricotopus sp.	-	3	136	-	-	-	20	12	50	-
Other Midges	-	-	6	-	-	-	-	-	-	-
Empididae	1	1	3	-	3	-	-	-	-	1
Atherix sp.	1	2	-	-	-	-	-	1	17	-
Tipulidae	1	5	2	2	-	-	-	-	39	1
Blepharoceridae	-	-	-	-	-	-	-	-	-	1
Nematodes	-	-	1	3	-	-	3	-	-	1
Sludgeworms	2	103	64	6	1	12	31	110	67	43
Number of Kinds	15	20	17	13	9	13	7	8	12	16
Number per Sq. Ft.	21[illegible]	398	69[illegible]	150	32	51	97	187	306	9[illegible]
CHEMICAL DATA - mg/l										
Total Iron	0.2	-	0.2	-	0.5	1.4	0.2	0.3	0.9	4.0
Chromium	<0.02	-	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese	<0.1	-	<0.1	-	<0.1	<0.1	<0.1	<0.1	0.1	0.1
Zinc	<0.02	-	0.02	-	0.02	<0.02	0.03	0.04	0.03	0.02
Copper	<0.02	-	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Molybdenum	<0.5	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	<0.01	-	<0.01	-	0.01	0.04	<0.01	0.01	<0.01	<0.01

TABLE 7

Colorado River Sampling Stations

C-1	Colorado River from State Highway 13 Bridge at Rifle.
RC-2	Rifle Creek on Highway 6-24 Bridge West of Rifle.
C-3	Colorado River at Water Intake of Union Carbide Plant at Rifle.
C-4	Colorado River at Rulison Bridge off Highway 6-24 about Six Miles Below Union Carbide.
C-5	Colorado River at 45 Rd. Bridge in DeBeque near Water Intake.
PC-6	Plateau Creek at Highway 65 Exit from I-70.
C-7	Colorado River at Bridge Entering Public Service Power Plant Near Cameo Exit from I-70.
C-8	Colorado River at Clifton Bridge in Clifton Above Grand Junction.
C-9	Colorado River at 5th Street Bridge in Grand Junction.
G-15	Gunnison River at Bridge N. of AEC Compound in Grand Junction.
C-10	Colorado River Wade in above Irrigation Return 1.2 Mi. on West Ave. after Right Off Highway 340.
C-11	Colorado River at Highway 340 Bridge above Fruita.
C-12	Colorado River Walk in at East Side of American Gilsonite Plant.
C-13	Colorado River at Loma - WPSS Station.
C-14	Colorado River at Westwater - 3 Mi. below Stateline.
C-16	Colorado River from State Highway 128 Bridge in Utah.
C-17	Colorado River at Highway 160 Bridge above Moab.
C-18	Colorado River below Moab.

TABLE 8

Colorado River
Grand Junction -
Bottom Fauna Data - No. Per Sq. Foot
July-August 1966

River Mileage	1119.8	1109.05	1108.5	1102.80	1102.8	1102.2	1102.2	1099.5	1099.5	1098	1091.1	1089	1084	1058.7	0995.10
	C-7	C-8 U.S	C-8 D.S.	C-9	C-9	C-9A	C-9A	C-9B	C-9C	C-10	C-11	C-11A	C-13	C-14	C-17
	Cameo	Clifton	Clifton	Main Chan.	Lf. Bk.	Main Chan.	Lf. Chan.	Rt. Bank	Lf. Bank	Lf. Chan.	Fruita	Salt Wash	Loma	Westwater	Moab
Stoneflies															
Brachyptera sp.		2	16												
Perlesta placida								7							
Mayflies															
Rhithrogena sp.	1							7					4	6	
Baetis sp.	7	15	32	16						4	8				
Pseudocloeon sp.	13	2		28				14		36	12		20	20	
Tricorythodes sp.	3	71	152	60		71		114		172	68		64	56	
Heptagenia sp.		16	48	12		6		41	2		16			4	8
Ameletus sp.		20	64							20					
Choroterpes sp.						5									
Traverella sp.		5		12				54						2	
Caddisflies															
Hydropsyche sp.	22	190	1384	424	47	40		194		140	52		20	12	
Cheumatopsyche sp.	38	104	800	288	7	77		340		84	16		40	6	4
Agraylea sp.		2						14			8				
Brachycentrus sp.		28	64												
Hydroptila sp.														2	
Arctopsyche sp.								68							4
Beetles															
Cylloepus sp.		1	16			1				4					
True Flies															
Blackflies															
Similium sp.														14	
Empididae	1			1					2						
Tipulidae			1												
Midges															
Pseudochironomus sp.		38	168								20				
Spaniotoma sp.	2	25	288	40	10	15		88	153	280	56		52	20	
Tendipes sp.		1													
Polypedilum sp.		9		40		10				116		51			
Pentaneura sp.			16			2				8					
Cricotopus sp.				8	70	14		82	102	160	40	3	4	28	
Cryptochironomus sp.						2									
Bloodworms															
Tendipes					18	5			2						
Nematode					2										
Slugeworms		5	16	12		5		7	3	472	124	7	4	2	
Total Kinds	8	17	14	12	6	13	0	13	6	12	11	3	8	12	3
Total No./Sq. Ft.	87	534	3065	941	154	253	0	1030	264	1496	420	61	208	172	16

TABLE 9

Slate River Sampling Stations

SAMPLING STATION	DESCRIPTION
S-1	Slate River-1 mile upstream of Standard mill
S-2	Slate River-50 feet upstream from the confluence with Coal Creek
SR-3	Coal River-50 feet upstream from the confluence with the Slate River
SR-4	Slate River-100 yards downstream of Coal Creek
SR-5	Coal Creek-100 yards upstream from Keystone Mill
SR-6	Mine drainage water sample only
SR-7	Coal Creek 100 yards downstream of Keystone Mine drainage
SR-8	Slate River-at Highway 131 crossing

TABLE 10

SLATE RIVER

Bottom Fauna Data
Number Per Square Foot

October 1966

	SR-1	SR-2	SR-3	SR-4	SR-5	SR-7	SR-8	SR-9
STONEFLIES								
Nemoura sp.	2				1			
Brachyptera sp.	7	10	2	2	2		1	
Pteronarcella sp.	1	2						
Isoperla sp.				2	1			
Leuctra sp.					5			
MAYFLIES								
Rhithrogena sp.	125	80			10		22	
Paraleptophlebia sp.	2	44		42				
Ephemerella sp.	3	30	1	64	8		14	
Baetis sp.	1		1	10			1	
Pseudocloeon sp.			2					
Heptagenia sp.			1				2	
CADDIS FLIES								
Polycentropus sp.	1				1			
Arctopsyche sp.	1		2		2		9	
Brachycentrus sp.	5	14	5		9		38	
Hydropsyche sp.		2					4	
Agraylea sp.				2				
Psychomyia sp.					1			
BEETLES								
Heterlimnius sp.				2				
Cleptelmis sp.							1	
MIDGES								
Spaniotoma sp.	5	10		20			4	
Pseudochironomus sp.	10			14			1	
Pentaneura sp.				2				
EMPIDIDAE					1			
TIPULIDAE		1		2				
PLANARIANS					4			
SLUDGEWORMS	20				11	2	10	
NEMATODES			1					
Number of Kinds	14	8	8	11	12	1	12	
Number Per Square Foot	184	192	15	162	56	2	107	
CHEMICAL DATA (mg/l):								
Total Iron	<0.2	0.2	<0.2	0.2	<0.2	11.0	0.2	22.6
Chromium	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	0.02	0.02
Manganese	<0.1	<0.1	0.2	<0.1	1.3	41.0	0.1	63.0
Zinc	0.02	<0.02	0.17	0.03	0.33	26.0	0.06	35.0
Copper	<0.02	<0.02	<0.02	<0.02	<0.02	1.6	0.07	2.3
Cadmium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	0.01	<0.01	<0.01	<0.01	<0.01	2.0	<0.01	3.37

TABLE 11

GUNNISON RIVER SAMPLING STATIONS

G-1	Gunnison River above Gunnison on Highway 135.
OhC	Ohio Creek, 2.5 Miles Up from Mouth.
G-3	Gunnison River below Gunnison about 3 Miles.
G-4	Gunnison River at Highway 149 Bridge above Headwaters of Blue Mesa Reservoir.
G-5	Gunnison River at Discharge Pipe from Blue Mesa Dam.
NFG-6	North Fork of Gunnison River above Paonia.
NFG-7	North Fork of Gunnison River below Paonia
NFG-8	North Fork of Gunnison River above Hotchkiss (B St.)
NFG-9	North Fork of Gunnison River below Hotchkiss at Abandoned Fish Hatchery.
G-10	Gunnison River on Highway 92 Bridge about 5 Miles E. of Delta.
G-11	Gunnison River on Highway 50 at Delta.
G-12	Gunnison River below Delta.
G-13	Gunnison River on Escalante Canyon Rd.
G-14	Gunnison River on Highway 141 Br.
G-15	Gunnison River in Grand Junction.

1101.8-	151 G-1	149.5-2.5 CHC	147.5 L. Bk. G-1A	144 R. Bk. G-3	144 G-3	138.7 G-4	72-18 NYG-6	72-15.0 NFG-7	72-13. NFG-7A	72-7.7 NFG-8	72-4.0 NFG-9	72-0.5 NFork G-9A	72-0.5 G-9A	62.9 G-10	56 L. Chan. G-11	52.6 G-12	42 G-13	148 G-14	15 G-15
Stoneflies																			
Pteronarcys sp.	1	2	1	-	-	92	-	-	-	-	-	-	-	-	-	-	-	-	-
Brachyptera sp.	1	2	-	-	4	8	8	-	-	-	-	-	-	-	4	-	-	-	-
Isoperla sp.	-	-	-	2	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Perlesta placida	-	-	-	-	4	12	4	-	-	-	-	-	-	-	-	-	1	-	-
Pteronarcella sp.	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-
Mayflies																			
Rhithrogena sp.	12	10	6	30	60	104	4	-	4	8	-	-	-	-	-	-	-	-	-
Ephemerella sp.	5	16	2	6	56	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Pseudocloeon sp.	13	6	3	92	300	96	4	2	20	-	-	-	12	24	84	-	2	-	2
Baetis sp.	53	54	2	14	100	24	-	-	4	-	-	-	6	128	44	2	5	2	-
Tricorythodes sp.	-	2	-	-	-	-	-	-	4	72	-	54	2	20	40	10	17	6	6
Heptagenia sp.	-	-	-	-	-	-	60	-	48	8	-	2	-	4	8	-	-	2	-
Paraleptophlebia sp.	-	-	-	-	-	-	-	2	24	24	-	-	-	-	2	-	-	-	-
Choroterpes sp.	-	-	-	-	-	-	-	-	-	-	16	18	-	-	-	-	-	-	-
Traverella sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4	-	-	10	70
Caddisflies																			
Hydropsyche sp.	5	20	-	16	92	28	124	[illegible]	280	480	3840	38	56	1080	960	280	19	254	50
Arctopsyche sp.	11	4	9	10	16	4	32	-	40	32	-	4	10	8	-	-	-	-	-
Glossosoma sp.	5	10	5	12	32	12	-	-	-	-	-	-	-	-	-	-	-	-	-
Brachycentrus sp.	12	140	33	10	160	-	16	-	4	-	-	-	-	-	-	-	-	-	-
Cheumatopsyche sp.	-	4	-	6	28	8	48	-	200	240	1968	30	26	188	408	98	7	100	33
Agraylea sp.	-	-	-	4	20	4	28	-	-	24	16	-	-	4	-	-	-	-	-
Beetles																			
Optioservus sp.	3	16	6	18	24	40	4	-	-	-	-	-	-	-	8	-	-	-	-
Heterlimnius sp.	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Cylloepus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-
True Flies																			
Blackflies																			
Prosimulium sp.	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-
Simulium sp.	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-
Midges																			
Spaniotoma sp.	14	22	55	100	120	40	240	-	108	284	224	16	6	52	72	10	6	20	2
Polypedilum sp.	3	-	15	58	56	16	160	-	84	60	224	18	8	32	112	12	-	12	-
Cricotopus sp.	-	6	25	-	-	-	84	-	-	-	-	-	-	-	-	18	8	4	-
Pseudochironomus sp.	-	-	-	-	20	8	-	-	24	64	-	10	-	24	24	-	-	22	2
Pentaneura sp.	-	-	-	-	-	-	-	-	-	-	-	4	-	-	8	-	-	-	-
Microtendipes sp.	-	-	-	-	-	-	-	-	-	-	-	10	-	12	-	-	-	-	-
Lepidoptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-
Atherix sp.	-	-	-	-	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-
Tipulidae	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deuterophlebiidae	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psychodidae																			
Pericoma sp.	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Sludgeworms	-	-	-	-	-	8	-	132	-	-	-	2	-	-	-	-	2	4	-
Total No. Kinds	15	16	12	14	17	20	15	4	15	11	6	12	8	14	14	7	9	13	8
Total No. Per Sq. Ft.	140	322	162	378	1096	532	820	137	856	1296	6288	206	126	1588	1778	430	67	446	184

TABLE 12 - GUNNISON RIVER

Bottom Fauna Data - No. Per Sq. Ft. (Cont.)

October 1966

River Mile:

1101.8-

Organism	56 G-11	55.2 G-11A	51.0 G-12	42 G-13	14.8 G-14	1.5 G-15	54.5 - 2.0 U-14	1.2 U-15	0.9 U-15A	0.4 U-16
Stoneflies										
Pteronarcys sp.	-	-	-	-	-	-	-	-	-	-
Brachyptera sp.	-	-	-	-	-	-	-	-	-	-
Isoperla sp.	-	-	-	-	-	-	-	-	-	-
Perlesta placida	-	-	-	-	-	-	-	-	-	-
Pteronarcella sp.	-	-	-	-	-	-	-	-	-	-
Mayflies										
Rhithrogena sp.	-	-	-	-	-	-	-	-	-	-
Ephemerella sp.	-	-	-	-	-	-	-	-	-	-
Pseudocloeon sp.	8	-	-	-	4	2	-	-	-	-
Baetis sp.	2	-	-	-	-	-	-	-	-	-
Tricorythodes sp.	10	-	3	126	20	3	12	4	-	2
Heptagenia sp.	2	-	-	-	-	1	-	-	-	-
Paraleptophlebia sp.	-	-	-	-	-	-	-	-	-	-
Choroterpes sp.	-	-	-	-	-	-	-	-	-	-
Traverella sp.	-	-	-	-	-	-	-	-	-	-
Caddisflies										
Hydropsyche sp.	368	-	53	40	40	12	37	3	-	-
Arctopsyche sp.	-	-	-	-	-	-	-	-	-	-
Glossosoma sp.	-	-	-	-	-	-	-	-	-	-
Brachycentrus sp.	-	-	-	-	-	-	-	-	-	-
Cheumatopsyche sp.	260	1	90	60	112	20	29	1	-	-
Agraylea sp.	10	-	11	38	76	-	1	-	-	-
Beetles										
Optioservus sp.	-	-	-	-	-	-	-	-	-	-
Heterlimnius sp.	-	-	3	-	-	-	-	-	-	-
Cylloepus sp.	-	1	5	-	4	-	-	-	-	-
True Flies										
Blackflies										
Prosimulium sp.	2	-	-	-	-	-	-	-	-	-
Simulium sp.	-	1	-	-	-	1	-	-	-	-
Midges										
Spaniotoma sp.	124	37	140	204	144	5	10	4	2	1
Polypedilum sp.	-	-	-	-	-	-	-	-	-	-
Cricotopus sp.	16	9	21	132	80	9	4	1	4	10
Pseudochironomus sp.	-	-	-	-	-	-	-	-	-	-
Pentaneura sp.	-	-	5	-	24	-	-	-	-	-
Microtendipes sp.	-	-	-	-	-	-	-	-	-	-
Cryptochironomus sp.	-	2	-	-	-	-	-	-	-	-
Lepidoptera	12	-	-	-	-	-	-	-	-	-
Atherix sp.	-	-	-	-	-	-	-	-	-	8
Tipulidae	-	-	-	-	-	-	-	-	-	-
Deuterophlebiidae	-	-	-	-	-	-	-	-	-	-
Psychodidae										
Pericoma sp.	-	-	-	-	-	-	-	-	-	-
Bloodworms										
Tendipes sp.	-	25	-	-	-	-	-	-	-	2
Sludgeworms	-	8	17	44	-	33	1	1	1	665
Total No. Kinds	11	8	10	7	9	9	7	6	3	6
Total No. per Sq. Ft.	814	84	348	864	512	86	94	14	7	688

TABLE 13 - orado and Gunnison River Fishery Data

July 1966

	Colorado River			Gunnison			North Fork	
River Mileage	1119.8C-7	1098C-10	1084C-13	1101.8-73	1101.8-52.6	1101.8-1.5	1101.8-72.3-7.7	1101.8-72.3-0.5
Fish	Cameo	Co.Rd.23	Loma	U.S. of No. Fork	3.5-mi.D.S. of Delta G-12	G-15 AEC Compound	No. Fork	No. Fork
Sculpin							6	3
Dace			1	2		32		7
Chub	17	3	7					
Large-Mouth Bass		1						
Green Sunfish		5	2			2		
Killfish					6			
Shiners		2	2		23			
Stonerollers						4		
Minnows						10		
Fathead Minnows		1				12		1
Mountain Sucker	1		19	22	5	2		
Fine Scale Sucker	5	3	21	2	12	2	21	
Channel Catfish			5					
Black Bullhead		2	2					
Carp		1		2	4	3	1	
Method	Net 4 Net Nights			200' 15 min.	Shocker 100' 8 min.	150' 12 min.	Shocker 100' 8 min.	100' 8 min.

TABLE 14

Cimarron River Sampling Stations

Station Number	Station Description
CI-1-6.2	Cimarron River 2 Miles Upstream of Gravel Washing Operation.
CI-2-3.9-0.2	Little Cimarron 0.2 Mile Upstream of Confluence with Cimarron River.
CI-3-3.5	Cimarron River 100 Yards Downstream of Gravel Washing Operation.
CI-4-1.5	Cimarron River at Highway 50 Crossing.
CI-5-1.0	Cimarron River 0.3 Miles Downstream of Dam Construction Camp.

TABLE 15

CIMARRON RIVER

CHEMICAL AND BOTTOM FAUNA DATA - NUMBER PER SQUARE FOOT

OCTOBER 1966

1101.8-108-	6.2	3.9-0.2	3.5	1.5	1
	CI-1	CI-2	CI-3	CI-4	CI-5
Stoneflies					
Pteronarcella sp.	4	-	-	-	-
Isoperla sp.	-	-	-	1	
Mayflies					
Ephemerella sp.	180	32	22	19	25
Rhithrogena sp.	8	-	-	-	-
Heptagenia sp.	-	-	2	-	-
Pseudocloeon sp.	-	-	-	2	1
Caddisflies					
Hydropsyche sp.	80	236	116	40	50
Cheumatopsyche sp.	136	120	40	14	20
Brachycentrus sp.	40	44	-	1	-
Arctopsyche sp.	-	-	-	-	2
Beetle					
Optioservus sp.	36	80	2	8	26
True Flies					
Blackflies					
Prosimulium sp.	-	4	-	-	-
Midges					
Spaniotoma sp.	480	96	16	48	90
Cricotopus sp.	64	28	6	20	10
Bloodworm					
Tendipes sp.	-	-	-	-	1
Biting Midges					
Bezzia sp.	-	-	-	3	-
Tipulidae	-	4	-	-	-
Dolichopodidae	8	-	-	-	-
Atherix sp.	8	-	-	1	5
Sludgeworms	332	184	8	78	272
Nemotodes	-	12	2	3	-
Number of Kinds	13	11	9	13	11
Number per Square Foot	1380	840	214	238	502
Total Suspended Solids, mg/l	17	39	118	169	142
Turbidity, Units	< 25	< 25	< 25	80	75

TABLE 16

UNCOMPAHGRE RIVER SAMPLING STATIONS

U-1	Uncompahgre River above Confluence with Red Mountain Creek.
RMC-2	Mouth of Red Mountain Creek.
U-3	Uncompahgre River above Ouray.
CC-4	Mouth of Canyon Creek.
OC-5	Mouth of Oak Creek.
U-6	Uncompahgre River in Ouray.
U-7	Uncompahgre River below Ouray 2 Miles.
U-8	Uncompahgre River above Ridgeway.
U-9	Uncompahgre River below Ridgeway.
U-10	Uncompahgre River above Montrose.
U-11	Uncompahgre River below Montrose.
U-12	Uncompahgre River above Olathe.
U-13	Uncompahgre River below Olathe.
U-14	Uncompahgre River above Delta.

17 [illegible] RIVER

Bottom Fauna Data - No. Per Sq. Foot

July-August 1966

1131.P-56.5-	68.0 U-1	67.8-7.6 Control Red Mt. Crk.	67.8-7.0 D.S. of Mine Drainage	67.8-7.1-0.1 Upstream of Idarado Mine Pond	67.8-5.7-0.3 Commodore Gulch	67.8-1.0 RMC-2	65.85 U-3	65.2-0.1 OC-4	65.1-0.1 OC-5	65.2 U-6	65.2 U-6	61.5 U-7	56.8 U-8	51.5 U-9	39 U-9A	37 Trib U-9B	29 U-10	23.8 U.S. of dam U-11-1	23.8 U.S. of dam U-11-2	19.4 U-12	11.5 U-13	2.0 U-14	1.2 U-15	1.2 C-1
Stoneflies																								
Nemoura sp.	12	9	-	6	-	-	-	-	16	*	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Isogenus sp.	2	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Pteronarcella sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Mayflies																								
Traverella sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21	-	-	-
Ironopsis sp.	39	1	-	3	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pseudocloeon sp.	19	2	-	1	-	-	-	13	16	*	1	-	3	4	12	8	6	60	120	140	143	-	-	-
Baetis sp.	-	-	-	1	-	-	-	-	20	-	-	-	21	28	40	16	27	23	60	116	100	-	-	-
Ephemerella sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	2	10	-	3	5	2	-	-	-	-	-
Tricorythodes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	25	18	130	15	-	2	-
Heptagenia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	10	8	-	-	-
Paraleptophlebia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	6	-	-	-	-
Rhithrogena sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	7	-	-	-
Caddisflies																								
Dicosmoecus	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brachycentrus sp.	-	-	-	2	-	-	-	-	-	-	-	-	-	-	4	-	1	-	-	-	-	-	-	-
Hydropsyche sp.	-	-	-	-	-	-	-	-	-	*	-	-	-	-	12	-	3	1	1	70	47	4	-	-
Arctopsyche sp.	-	-	-	-	-	-	-	-	-	-	1	-	-	4	116	-	1	-	-	-	-	-	-	-
Rhyacophila sp.	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Cheumatopsyche sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	5	-	-	-
Glossosoma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Beetles																								
Optioservus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-	-	-
True Flies																								
Blackflies																								
Prosimulium sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	4	40	-	-	-
Simulium sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-
Midges																								
Spaniotoma sp.	2	-	-	30	2	-	-	18	20	*	5	-	-	68	64	64	7	12	17	70	40	-	-	28
Cricotopus	3	-	-	34	-	-	-	-	-	*	-	-	-	-	24	-	-	3	-	-	5	-	-	12
Polypedilum sp.	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	24	-	4	-	-	15	-	-	8
Pseudochironomus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	40	20	-	-	8
Pentaneura sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-
Biting Midges																								
Bezzia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-
Blephariceridae	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atherix sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
Empididae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	1	1	-	6	3	-	-	-
Tabanidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Planarians	-	-	-	-	-	-	-	-	8	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludgeworms	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	5144	-	9	-	-	13	-	-	-
Number of Kinds	6	4	0	8	1	0	0	2	7	8	5	0	2	8	10	6	11	13	10	10	17	2	1	4
No. Per Sq. Foot	68	6	0	84	2	0	0	31	88	Qual.	16	0	24	114	286	5264	55	147	204	792	491	5	2	56

* Collected and qualitative sample only.

TABLE 18

Uncompahgre River

Fish Data

July 1966

River Mileage 1101.8-545-	64.9	54	29	27
	Ouray	Between Ridgeway and Colona	Upstream of Montrose	Downstream of Montrose
Fish	U-6	U-9	U-10	U-11
Trout	0	0	2	1
Sculpin	0	2	0	0
Dace	0	12	18	91
Chub	0	0	0	2
Minnows	0	0	0	1
Mountain Sucker	0	25	53	452
Fine Scale Sucker	0	2	43	137
Bullhead	0	0	0	1
Method	Shocker 12 min. 150'	Net 4 Net Days	Net 4 Net Days	Net 4 Net Days

TABLE 19

Upper Dolores River Sampling Stations

Station Number	Station Description
D-1	.5 Miles Upstream of Gravel Washing Operation, 1.9 Miles Upstream of Rico.
D-2	.5 Miles Downstream of Gravel Washing Operation, 0.9 Miles Upstream of Rico.
D-5	.1 Mile Upstream of the Confluence with Silver Creek.
D-6	Silver Creek Upstream of Rico Argentine Mining Co.
D-9	Silver Creek 0.1 Mile Upstream of Confluence with the Dolores River.
D-9A	0.2 Miles Upstream of Silver Swan Mines.
D-10	2.5 Miles Downstream of Rico.
D-11	4 Miles Downstream of Rico Montoloras Bridge.
D-12	Upstream of Confluence with West Dolores-Stoner Creek.
D-13	West Dolores - 0.4 Miles Upstream from Confluence.
D-14	Dolores River at Dolores.

TABLE 20- DOLORES RIVER

Rico - Dolores, Col.
Bottom Fauna Data - No. Per Square Foot
October 1966

1027.1	River Miles: 237	236	235.1	235.0-13[1]	235.0-.1[1]	234	232.5	231	212.7	210[2]	195
Organism	D-1	D-2	D-5	D-6	D-9	D-9A	D-10	D-11	D-12	D-13	D-14
Stoneflies											
Brachyptera sp.	6	3	1	3	-	2	-	1	3	4	4
Nemoura sp.	1	2	-	2	-	-	-	-	-	-	-
Isoperla sp.	-	1	-	-	-	-	-	-	-	-	-
Pteronarcys sp.	-	-	-	-	-	-	-	-	-	2	-
Mayflies											
Ephemerella sp.	24	8	17	7	-	2	2	-	3	33	20
Rhithrogena sp.	63	20	42	3	-	21	2	5	7	23	17
Heptagenia sp.	-	2	-	-	-	-	-	-	-	-	9
Baetis sp.	-	-	-	1	-	-	1	-	1	-	-
Pseudocloeon sp.	-	-	-	-	-	-	-	-	-	2	-
Caddisflies											
Arctopsyche sp.	10	10	41	-	1	-	5	5	2	30	5
Glossosoma sp.	2	-	-	-	-	-	-	-	10	63	5
Brachycentrus sp.	17	15	14	-	4	7	-	15	17	20	11
Psychomyia sp.	1	-	2	7	10	-	-	-	-	5	-
Hydropsyche sp.	-	-	-	-	-	-	-	-	7	70	20
Helicopsyche sp.	-	-	-	-	-	-	-	-	-	-	1
Cheumatopsyche sp.	-	-	-	-	-	-	-	-	-	-	43
Beetles											
Optioservus sp.	-	-	-	-	-	-	-	-	-	24	1
True Flies											
Blackflies											
Prosimulium sp.	-	-	-	-	-	-	-	-	-	1	-
Midges											
Spaniotoma sp.	-	-	-	-	1	1	-	-	1	1	-
Microtendipes sp.	-	-	-	-	-	-	-	-	-	-	14
Tipulidae	2	1	-	2	-	-	-	-	-	1	-
Blepharoceridae	1	-	-	-	-	-	-	-	1	-	-
Atherix sp.	-	-	-	-		-	-	1	1	9	-
Planarians	-	-	-	1		-	-	-	-	-	-
Sludgeworms	16	-	-	-		-	-	-	-	-	-
Number of Kinds	11	9	6	8	3	5	4	5	11	15	12
Total No./sq. Foot	143	62	117	26	15	33	10	27	53	288	150
CHEMICAL DATA - mg/1											
Total Iron	< 0.2	10.2	10.1	-	0.5	1.4	8.3	-	0.2	< 0.2	< 0.2
Chromium	< 0.02	< 0.02	< 0.02	-	< 0.02	< 0.02	< 0.02	-	< 0.02	< 0.02	< 0.02
Manganese	< 0.1	0.3	1.0	-	1.0	0.9	1.0	-	< 0.1	< 0.1	< 0.1
Zinc	< 0.02	0.06	0.11	-	0.67	0.30	0.29	-	< 0.02	< 0.02	< 0.02
Copper	< 0.02	< 0.02	< 0.02	-	< 0.02	< 0.02	< 0.02	-	< 0.02	< 0.02	< 0.02
Molybdemum	< 0.5	< 0.5	< 0.5	-	< 0.5	< 0.5	< 0.5	-	< 0.5	< 0.5	< 0.5
Lead	0.02	-	0.04	-	0.15	0.16	-	-	0.02	0.02	0.02
Total Suspended Solids	2	312	-	-	-	-	220	-	-	-	-
Turbidity - Units	< 25	450	-	-	- -	-	-	-	-	-	-

1. Silver Creek

2. West Dolores River

Table 21

Lower Dolores and San Miguel Rivers

STATION NUMBER	STATION DESCRIPTION
SM-1	Marshall Creek - 4 miles southwest of Telluride, Colorado; 100 yards upstream from its confluence with Savage Creek.
SM-2	Savage Creek-100 yards upstream from its confluence with Marshall Creek; 4 miles scutheast of Telluride, Colorado.
SM-3	Water sample only - downstream of Pen Tunnel Mine; 1,000 yards downstream of SM-1.
SM-4	Marshall Creek-100 feet upstream from its confluence with the San Miguel River in the Idardo Mill property.
SM-5	Bridal Creek-1/4 mile upstream from Bridal Falls.
SM-6	Ingram Falls-100 yards upstream from its confluence with the San Miguel.
SM-7	Meldrum Tunnel drain - 300 yards upstream from where it joins Ingram Falls Creek.
SM-8	San Miguel River-150 yards upstream from the Idardo Mill.
SM-9	San Miguel River-at the downstream boundary of the Idardo Mill property.
SM-10	San Miguel River-at the upstream edge of Telluride, Colorado.
SM-11	San Miguel River-150 yards downstream of Telluride, Colorado.
SM-12	San Miguel River-at Highway 145 bridge.
SM-13	San Miguel River-1,000 yards upstream from the confluence of the South Fork.
SM-14	Howard's Fork-at the upstream crossing six miles upstream from Ophir, Colorado.

Table 21 (Continued)

STATION NUMBER	STATION DESCRIPTION
SM-15	Discharge from an unnamed mine 100 yards downstream from SM-14.
SM-16	Drainage from the Yellow Jacket Mine.
SM-17	Mine drainage located between the Iron Springs and the old Ophir cemetery.
SM-18	The upstream side of the iron diggings for the paint pigment.
SM-19	Drainage from the spring flowing through the iron diggings.
SM-20	One hundred yards downstream from the iron diggings.
SM-21	Drainage from the Silver Hat Mine.
SM-22	Howard's Fork-downstream from the old Ophir cemetery
SM-23	Drainage from the mine located 150 yards downstream from the old Ophir mine.
SM-24	One hundred yards upstream from the Silver Bell Mine.
SM-25	Drainage from the Silver Bell Mine.
SM-26	150 yards upstream of the power plant.
SM-27	Water sample only from the South Fork, just downstream from the confluence of the Lake Fork and Howard's Fork.
SM-28	South Fork-six miles upstream from the confluence with the San Miguel River.
SM-29	South Fork-1,000 yards upstream from the confluence with the San Miguel.
SM-30	San Miguel River at Placerville.

Table 21 (Continued)

STATION NUMBER	STATION DESCRIPTION
SM-31	San Miguel River-at Norwood, Colorado, Highway 145 crossing.
SM-32	San Miguel River-at Highway 97 in Naturita.
SM-33	San Miguel River-1,000 yards downstream from the Naturita sewage treatment plant.
SM-34	San Miguel River-1,000 yards downstream from the Vanadium Corporation of American mill at Naturita.
SM-35	San Miguel River-on the upstream edge of Uravan, Colorado.
SM-36	San Miguel River-100 yards downstream of the Number 5 waste discharge.
SM-37	San Miguel River-1/2 mile downstream from the Union Carbide mill.
SM-38	Dolores River-at Bedrock, Colorado.
SM-39	Dolores River-3 miles downstream from Bedrock, Colorado.
SM-40	Dolores River-6 miles downstream from the confluence with the San Miguel.
SM-41	Dolores River-5 miles upstream from Gateway, Colorado.
SM-42	Dolores River-at Gateway, Colorado, on the 141 bridge crossing.

TABLE 22

DOLORES AND SAN MIGUEL RIVERS

BOTTOM ORGANISM AND CHEMICAL DATA

October 1966

(Continued)

	SM-1	SM-2	SM-3	SM-4	SM-5	SM-6	SM-7	SM-8	SM-9	SM-10	SM-11	SM-12	SM-13	SM-14
STONEFLIES														
Isoperla sp.					6									
Nemoura sp.					69						5	9	1	33
Taeniopteryx sp.					7			12			5	1		
Pteronarcella sp.														
Brachyptera sp.					1							2		3
Leuctra					17									2
MAYFLIES														
Rhithrogena sp.					8						8			17
Pseudocloeon sp.											2	3	18	
Ephemerella sp.											5	2		
Baetis sp.											3	2	2	1
Heptagenia sp.					19			2						
Trichorythodes sp.														
CADDIS FLIES														
Helicopsyche sp.														
Agraylea sp.														
Leptocella sp.														
Polycentropus sp.					2								1	20
Psychomyia sp.					6			1			2		4	11
Arctopsyche sp.								2					19	
Glossosoma sp.														
Brachycentrus sp.											1	2	63	1
Cheumatopsyche sp.														
Hydropsyche sp.				NO ORGANISMS : SILTS										
BEETLES														
Cylloepus sp.														
Optioservus sp.														
BLACK FLIES														
Prosimulium sp.														
Simulium sp.														
MIDGES														
Polypedilum sp.														
Spaniotoma sp.					5			1			4	3	1	2
Cricotopus sp.					2						1			
Brillia sp.														1
Pentaneura sp.														
Pseudochironomus sp.					4									
Cryptochironomus sp														
BITING MIDGES														
Bezzia sp.												1		
BLEPHAROCERIDAE														
EPHYDRIDAE														
RHAGIONIDAE														
TIPULIDAE											1			
EMPIDIDAE									1					
PLANARIANS								32		1	1			
SLUDGEWORMS					1			1				1	1	1
Number of Kinds				0	13			7	1	1	12	10	9	13
Number per Square Foot				0	147			51	1	1	38	26	110	147

CHEMICAL DATA - mg/1:	SM-1	SM-2	SM-3	SM-4	SM-5	SM-6	SM-7	SM-8	SM-9	SM-10	SM-11	SM-12	SM-13	SM-14
Total Iron	0.6	<0.2	0.6	0.9	<0.2	<0.2	1.0	0.8	1.2	0.6	0.3	<0.2	-	0.6
Chromium	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02
Manganese	13.8	<0.1	7.4	6.7	<0.1	<0.1	0.2	0.1	3.3	2.1	1.0	<0.1	-	0.1
Zinc	6.0	2.6	4.8	4.5	0.04	0.47	1.2	0.45	2.3	1.4	0.62	.09	-	0.02
Copper	0.14	<0.02	0.10	1.1	<0.02	<0.02	0.06	0.04	0.07	0.05	0.02	<0.02	-	<0.02
Molybdenum	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5
Lead	0.04	0.05	0.02	0.34	0.06	0.02	-	0.12	0.37	0.17	0.08	0.02	-	0.02

TABLE 22

DOLORES AND SAN MIGUEL RIVERS

BOTTOM ORGANISM AND CHEMICAL DATA

October 1966

(Continued)

	SM-15	SM-16	SM-17	SM-18	SM-19	SM-20	SM-21	SM-22	SM-23	SM-24	SM-25	SM-26	SM-27	SM-28
STONEFLIES														
Isoperla sp.														
Nemoura sp.				6				40		63		55		22
Taeniopteryx sp.								2		3				
Pteronarcella sp.												4		17
Brachyptera sp.				1										
Leuctra sp.														
MAYFLIES														
Rhitrogena sp.				2				5		23		10		30
Pseudocloeon sp.										1				3
Ephemerella sp.														8
Baetis sp.														
Heptagenia sp.														
Trichorythodes sp.														
CADDIS FLIES														
Heliopsyche sp.														
Agraylea sp.														
Leptocella sp.										1				
Polycentropus sp.				1				2		4		3		
Psychomyia sp.				4		1		5		10		15		7
Arctopsyche sp.										23		3		13
Glossosoma sp.														
Brachycentrus sp.														15
Cheumatopsyche sp.				1										
Hydropsyche sp.														
BEETLES														
Cylloepus sp.														
Optioservus sp.														
BLACK FLIES														
Prosimulium sp.														
Simulium sp.														
MIDGES														
Polypedilum sp.														
Spaniotoma sp.				1				14		2				
Cricotopus sp.								2				1		
Brillia sp.	2			2				6						
Pentaneura sp.														
Pseudochironomus sp.														
Cryptochironomus sp.														
BITING MIDGES														
Bezzia sp.														8
BLEPHAROCERIDAE														
EPHYDRIDAE														
RHAGIONIDAE														
TIPULIDAE														
EMPIDIDAE								1						
PLANARIANS														
SLUDGEWORMS														
Number of Kinds	1			8		1		9		9		7		9
Number per Square Foot	2			18		1		77		130		91		123
CHEMICAL DATA - mg/l:														
Total Iron	1.0	20.0	6.0	0.4	3.6	22.0	2.0	0.7	10.1	0.5	1.1	0.5	0.7	0.2
Chromium	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese	0.2	1.2	1.3	0.1	1.0	0.4	1.8	0.2	2.5	0.2	0.6	0.2	0.1	0.1
Zinc	0.04	0.31	0.08	<0.02	0.33	0.02	1.4	0.15	0.19	0.10	0.14	0.08	0.10	0.04
Copper	<0.02	<0.02	0.04	<0.02	0.53	0.02	0.07	<0.02	0.10	<0.02	0.05	<.02	<0.02	<0.02
Molybdenum	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	0.02	0.14	0.02	0.03	0.02	0.05	0.05	0.05	0.05	0.02	0.02	0.02	0.02	0.02

TABLE 22

DOLORES AND SAN MIGUEL RIVERS

BOTTOM ORGANISM AND CHEMICAL DATA

October 1966

	SM-29	SM-30	SM-31	SM-32	SM-32A	SM-33	SM-34	SM-35	SM-36	SM-37	SM-38	SM-39	SM-40	SM-41	SM-42
STONEFLIES															
Isoperla sp.															
Nemoura sp.		1													
Taeniopteryx sp.															
Pteronarcella sp.	1	17	2												
Brachyptera sp.		4	2		1			2							
Leuctra															
MAYFLIES															
Rhithrogena sp.	14	9													
Pseudocloeon sp.	1					2									
Ephemerella sp.	2				3										
Baetis sp.					2	8	1								
Heptagenia sp.				4				2							
Trichorythodes sp.						2	3			1	2				
CADDIS FLIES															
Helicopsyche sp.											5				
Agraylea sp.					1	8									
Leptocella sp.							1								
Polycentropus sp.															
Psychomyia sp.															
Arctopsyche sp.	7	2	1												
Glossosoma sp.	9	81													
Brachycentrus sp.	9	10	132		3	8									
Cheumatopsyche sp.			2	2	14	210	3	8		1	102		9		4
Hydropsyche sp.		15	8	48	124	4	12	1		*	40		35		4
BEETLES															
Cylloepus sp.					7	8			2	*					3
Optioservus sp.											3				
BLACK FLIES															
Prosimulium sp.															3
Simulium sp.						2									2
MIDGES															
Polypedilum sp.										1					
Spaniotoma sp.			1		9	74		3	1					4	4
Cricotopus sp.			1										7		11
Brillia sp.														2	
Pentaneura sp.					6	6	2		1						
Pseudochironomus sp.					1		2								
Cryptochironomus sp.						12		1							
BITING MIDGES															
Bezzia sp.	4				1		1								
BLEPHAROCERIDAE															
EPHYDRIDAE										1					
RHAGIONIDAE						2			6	*			3		1
TIPULIDAE						2	2	1							
EMPIDIDAE						4									
PLANARIANS															
SLUDGEWORMS					18	12	1	8	4	2				1	1
Number of Kinds	8	7	8	3	13	16	10	8	6	8	5	0	4	3	9
Number per Square Foot	47	124	156	14	115	484	20	37	15	9	152	0	54	7	33
CHEMICAL DATA - mg/l:															
Total Iron	0.5	-	-	0.6	-	0.5	2.6	2.2	-	4.0	0.8	0.2	1.2	1.0	1.2
Chromium	<0.02	-	-	<0.02	-	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese	<0.1	-	-	0.1	-	0.1	0.2	0.1	-	0.4	<0.1	<0.1	<0.1	0.1	0.1
Zinc	0.06	-	-	0.03	-	0.03	0.04	0.03	-	0.26	<0.02	<0.02	0.03	0.02	<0.02
Copper	<0.02	-	-	<0.02	-	0.02	0.02	<0.02	-	0.09	<0.02	0.02	<0.02	0.02	<0.02
Molybdenum	<0.5	-	-	<0.5	-	<0.5	<0.5	<0.5	-	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	0.02	-	-	0.06	-	0.06	0.04	0.02	-	0.04	0.02	0.04	0.02	0.04	0.04

*Collected and [illegible]

TABLE 23

PRICE RIVER SAMPLING STATIONS

P-19	Price River on Highway 50 Upstream of Castle Gate Bridge 0.6 Mile.
P-20	Price River at Bridge into Castle Gate above ABC Independent Coal and Coke Company.
P-21	Price River on Highway 33 below ABC Company at Power Plant.
P-22	Price River above Helper.
P-23	Price River 2.5 Miles below Helper on Highway 6-50 Bridge.
P-24	Price River at Carbon St. Bridge in Price.
P-25	Price River below Price Sewer Outfall.
P-26	Price River at Highway 296 Bridge South of Wellington.
FW-27	Flood Wash Upstream of Carbon Dioxide Chemical Company.
FW-28	Flood Wash Walk in at East Wellington R.R. Bridge.
P-29	Price River at Wellington Coal Cleaning Co. Pump Intake.
IW-30	Icelander Wash from Highway 50 Bridge.
P-31	Price River at Highway 6-50 Bridge at Roadside Geyser Standard Station.
G-32	Green River at Highway 6-50 Bridge E. of Town of Green River.

TABLE 24

Price River - Bottom Organism Data - August 1966

												Green River
River Mileage 929.9-135.6-	117.5	112.0	104	103	102.2	97.1	89.3	80.0	80	34.0	21.2	929.9-118.20
	P-19A	P-19B	P-19	P-20	P-22	P-23	P-24	P-26	P-26A	IW-30	P-31	G-32
Organisms	Above Conflu. of White	3 mi down from Hi. Brid.	Castle Gate	Power Plant	Upstream of Helper	Down from Helper	Upstream Brid @ Price	E. Wellington Around Bridge	Below W. Bridge	Icelander Wash	Sub-strate	
Mayflies												
Heptagenia sp.	7	7				15						
Rhithrogenia sp.		1			3	1						1
Baetis sp.	47	4	100	13	4	43						
Pseudocloeon sp.	11	5	18	1	1	15						
Ephemerella sp.		1										1
Tricorythodes sp.												
Trichoptera												
Hydropsyche sp.	31	7	13	10	4					2	2	
Cheumatopsyche sp.	10	10	11	6								
Brachycentrus sp.	1	25			2	2				2		
Agraylea sp.	1	1										17
Potamyia sp.												
Blackflies												
Simulium sp.	52			1		2				5	35	
Prosimulium sp.	90					7						
Midges							NO ORGANISMS					
Polypedilum sp.	33	13				13		7	34			
Pseudochironomus sp.	16	2								17		
Spaniotoma sp.	24					25				3		
Brillia sp.		2							2	36	4	
Cricotopus		3						2				
Pentaneura sp.												
Sludgeworms	15	3			1	17		36	112	2	1	
								"Coal Chunks"	"Coal Chunks"	"Slime"		
Beetles												
Ampumifes sp.	4											
Optioservus sp.	1	1										
Leeches	1	1										
Stoneflies												
Brachyptera sp.			1	2	2						1	
Bloodworm												
Atherix sp.	2		4		1	3						
Empididae	1											
Stratiomyidae		1										
Dolichopodidae								3				
Biting Midges												
Bezzia sp.									7			
Kinds	18	17	6	6	8	11		4	4	6	5	3
Number	347	87	147	33	18	143		48	155	67	43	19

TABLE 25

SAN JUAN SYSTEM STATION DESCRIPTION

SJ-1	Bridge Downstream of Aneth, Utah.
SJ-2	Colorado State Route 40 (Arizona State Route 364) Bridge near Four Corners.
SJ-3	Downstream of Shiprock, New Mexico, Area Est. Four (4) Miles - U.S.G.S. Cable Car.
SJ-4	Bridge at Shiprock, New Mexico - U. S. Highway 666.
SJ-5	Upstream of Shiprock and Downstream of Farmington - Bridge off Highway 489
SJ-6	Walk-In Station Below Bloomfield Outfall.
SJ-7	Highway 44 Bridge South and Upstream of Bloomfield.
SJ-7A	San Juan Downstream of Blue Mesa Dam.
SJ-8	San Juan River near Carracas, Colorado.
SJ-9	San Juan River Downstream of Pagosa Springs.
SJ-10	Highway 160 Bridge Crossing San Juan Upstream of Pagosa Springs.
MC-11	McElmo Creek at Aneth, Utah. Highway 262 Crossing.
MC-12	County Road Bridge, Est. Eight (8) Miles Downstream of Cortez, Colorado.
MC-13	Highway 666 Bridge Crossing McElmo Creek downstream of Cortez, Colorado, outfall.
MC-14	County Road Bridge Crossing McElmo Creek Directly Opposite Colorado Route 145 to Dolores.
LP-14A	La Plata River at La Plata.
AR-15	Highway 17 Bridge Crossing Animas River Upstream of Farmington Outfall.

TABLE 25 (Cont.)

SAN JUAN SYSTEM STATION DESCRIPTION

AR-16	Wade-in Station at Flora Vista Downstream of Aztec.
AR-17	Highway 550 Bridge Upstream of Aztec at Cedar Hill.
AR-18	U.S.G.S. Gage Station, Est. Two Miles Upstream of Colorado-New Mexico State Line.
AR-19	County Road Bridge About One Mile South and Downstream of Durango, Colorado.
AR-20	County Road Bridge Crossing Animas River Upstream of Durango, Colorado.
AR-21	Walk-in Approximately One-Half Mile Below Confluence of Mineral Creek and Animas River.
AR-22	Above Silverton - Highway 110 Bridge.
AR-23	Extension of Highway 110 Bridge Near Eureka, Colorado.
MI-24	Mineral Creek at Railroad Bridge Downstream of Silverton Outfall and just Upstream of Confluence with Animas River.
MI-25	Mineral Creek at Highway 550 Bridge in Silverton - Above Municipal Outfall.
CC-26	Cement Creek at Highway 110 Bridge in Silverton.
LP-27	The Most Downstream Station Possible on the Los Pinos Above the Reservoir.
LP-28	Wade-in Sample Approximately One Mile Downstream of the Ignacio Discharge.

TABLE 25 (Cont.)

SAN JUAN SYSTEM STATION DESCRIPTION

LP-29	The Most Upstream Station in the Ignacio Area.
LP-30	Downstream of Bayfield Discharge.
LP-31	Highway 160 Bridge Upstream of Bayfield.
PR-32	County Road Bridge off Highway 151 just above Stream's Entrance to the Reservoir above Arboles.

TABLE 26 - SAN JUAN BOTTOM ORGANISM DATA - JULY-AUGUST 1966

River Mileage 789.6 -	158.6	158.6	158.6	165	165	186	213	213	216.2	216.2	235	262	262	263	263.8	263.2
Organism	SJ-1 Rt. Bk.	SJ-1 Lt. Bk.	SJ-1 Rt. Center	SJ-1A Downstream	SJ-1A Upstream	SJ-2	SJ-3 Side Chan.	SJ-3 Mid Chan.	SJ-4 Main Chan.	SJ-4 Rt. Chan.	SJ-5	SJ-6 Main Chan.	SJ-6 Side Chan.	SJ-7E D.S. of Eff.	SJ-7 Rt. Bk. 200'downstream	SJ-7 Rt. B
Stoneflies																
Brachyptera sp.		3	1					1								
Isoperla sp.						3				2	1		2			
Mayflies																
Traverella sp.	4	219	3	5	40				1			4	4	1	3	13
Ameletus sp.	1	5	12		16											4
Pseudocloeon sp.		25	38		31	19		130	20	43	25	46	66			20
Baetis sp.		30	2	4		4		17	5	5	5	4	12		1	25
Tricorythodes sp.		10	1	4	3				1	2	10	15	32		40	
Heptagenia sp.		5	1		3	3		2	2		9		10			21
Ephemerella sp.		1										9	36			
Caddisflies																
Hydropsyche sp.	9	210	94	2	50	22		200	10	15	109	25	112	1	3	102
Cheumatopsyche sp.		250	10	30	41	66		40	5	12	60	35	52			30
Potamyia sp.		53														
Brachycentrus sp.											1					
True Flies																
Tipulidae																
Hexatoma sp.		1														
Blackflies																
Simulium sp.	4	16	8	1	1	2		4			7					
Prosimulium sp.																
Midges																
Brillia sp.	1									2						
Pentaneura sp.		2														
Polypedilum sp.		39	5			8		29			72	125	170	85		
Spaniotoma sp.		90	5		1	9	15	69	21	38	120	105	404	18	12	61
Pseudochironomus sp.			5	2	2	2									13	
Cricotopus sp.					2	6	25	51	14	20	40	34	60	25	5	74
Cryptochironomus sp.															7	
Harnischia sp.														7	9	
Empididae						3										
Snails												2			1	
Leeches													1			
Planarians																
Sludgeworms		1					1				1		273	27	16	
Total Kinds	5	17	13	8	11	12	3	10	9	9	14	12	15	7	11	10
Total No. sq. ft.	19	960	185	48	190	144	41	543	79	139	531	405	1235	174	110	492

San Juan River Cont.

TABLE 26

Los Pinos River

789.6-295.9

River Mileage	265	265	292	325.9	361	361	361	362.4	16	85.8	33.4
	SJ-7B	SJ-7B	SJ-7A	SJ-8	SJ-9	SJ-9	SJ-9	SJ-10	LP-27	LP-29	LP-31
Organism	Rt. Bk.	Lt. Bk.	Lt. Bk.		Rt. Side	Lt. Side	Mid-Chan.		Center	1-Surb	
Stoneflies											
Brachyptera sp.				2	1			3			
Perlesta sp.				1							
Pteronarcys sp.				1			1	5			1
Perlinella sp.											3
Mayflies											
Tricorythodes sp.	9	9	2		1	5	1		84	2	
Heptagenia sp.			1	4	4	5	4	16	4		
Rhithrogenia sp.				6	1			10			1
Ephemerella sp.	36	3	40	2	3	9	1		60	2	5
Baetis sp.	36	9	29	4	4		2	29	28		1
Pseudocloeon sp.	40	9	96		7		8		50	48	9
Paraleptophlebia sp.											1
Treverella sp.		3									
Caddisflies											
Hydropsyche sp.	220	21	40	29					80	12	5
Cheumatopsyche sp.	62	3	20	5					40	30	3
Glossosoma sp.					22	20	32	74			
Arctopsyche sp.					3		13	3			
Hydroptila sp.					1			14	1	1	
Brachycentrus sp.									2		55
Leptocella sp.											1
Agraylea		3									
Beetles											
Optioservus sp.						8	1	1		2	4
Cylloepus sp.										2	
Atheux sp.					1		1				
True Flies											
Tipulidae					2			1			
Blackflies											
Simulium sp.	46	3	4				1	1	10	2	6
Prosimulium sp.			15				1				1
Midges											
Polypedilum sp.	200	80	90				4		90	20	7
Spaniotoma sp.	370	320	126	15	21	38	18	2	28	8	18
Cricotopus sp.		30		6	15					12	
Harnischia sp.											
Pseudochironomus sp.	80	80		2			5			8	
Pentaneura sp.											6
Microtendipes sp.											
Biting Midges											
Bennia sp.	1										
Snails											
Empididae		3									
Sludgeworms	40	57			2	1	2		2	12	1
Total Kinds	11	14	11	12	14	7	15	12	13	14	19
Total No/sq ft	1,060	633	471	77	88	86	94	160	1,485	395	132

TABLE 27 SAN JUAN BASIN - Fishery Data - July 1966

	San Juan River Shiprock 789.60		San Juan River Bloomfield 789.60		Animas R. Silverton 789.60 - 249.00			Mineral Cr. 789.60-249.00-106-			Cement Cr. 789.60-249.00-107-		Animas R. Durango 789.60-249.00		Animas R. 789.60-249.00	Animas R. 789.60-249.00
	Down-stream	Up-stream	Down-stream	Up-stream	Down-stream	Up-stream	Central	Down-stream	So. Fork	Up-stream	Down-stream	Up-stream	Up-stream	Down-stream	Stateline	Farmington
River Mileage	210	210	262.8	265	105.9	111.2	115.1	0.5	03-0.5	04.	0.5	03.	598	55.8	38.2	0.1
Station No.	SJ-4	SJ-4	SJ-6	SJ-7B	AR-21	AR-22	AR-23	MI-25	MI-25A	MI-25B	CC-26	CC-26A	AR-20	AR-19	AR-18	AR-15
Trout	0	0	0	0	0	1	0	0	0	14	0	0	0	2	0	0
Sculpin	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0
Dace	47	65	0	8	0	0	0	0	0	0	0	0	4	12	134	20
Chub	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Fathead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Mountain Longnose sucker	0	0	4	9	0	0	0	0	0	0	0	0	12	41	26	22
Fine scale Sucker	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green Sunfish	9	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Catfish	3	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bullhead	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0
Carp	51	4	69	12	0	0	0	0	0	0	0	0	0	0	3	6
Method	Shocker 15 min. 400'	15 min. 400'	Net Four Net Nights		Shocker 8 min. 100'	5 min. 75'	8 min. 100'	Shocker 8 min. 100'	8 min. 100'	8 min. 100'	Shocker 5 min. 75'	5 min. 75'	Net Four Net nights		Net Four Net nights	Shocker 10 min. 120'

TABLE 2B Animas River

[illegible]

Bottom F[illegible]na No./Sq. Foot

July 1966

[illegible]	115.1 AR-23	111.9 AR-22	106.9 Lf Chan AR-21	106.9 Main Chan AR-21	98 AR-21A	57.9 Center Chan AR-20A	57.0 Lf Bk AR-20A	57.0 1 Sq. Yd. AR-20A	56.7 AR-19B	56.7 1 Sq. Yd. AR-19B	55.8 AR-19	54 AR-19A	54 Sq. Yd. AR-19A	39.5 AR-18A	39.5 Sq. Yd. AR-18A	38.2 Lf. Bk. AR-18	38.2 Rt. Bk. AR-18	38.2 Sq. Yd. AR-18	28.0 Rt. Bk. AR-17
Stoneflies																			
Brachyptera sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
Isoperla sp.	-	-	1	-	-	-	1	-	-	4	-	1	-	-	-	-	-	-	-
Pteronarcys sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-
Nemoura sp.	2	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Paraperla sp.	-	-	-	-	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-
Isogenus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alloperla sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mayflies																			
Heptagenia sp.	-	-	1	-	-	-	3	-	-	4	1	-	-	-	-	-	-	-	-
Ephemerella	-	-	-	-	-	1	10	92	12	98	21	3	400	-	24	1	10	60	3
Baetis sp.	-	-	1	-	-	9	38	36	22	-	51	29	8	24	16	41	113	56	32
Pseudocloeon sp.	2	2	3	-	3	9	25	24	12	-	13	20	4	24	-	13	80	68	45
Rhithrogena sp.	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Tricorythodes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Choroterpes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cinygmula sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isonychia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caddisflies																			
Rhyacophila sp.	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydropsyche sp.	-	-	-	-	-	-	-	-	-	-	15	25	2	112	120	40	87	124	10
Cheumatopsyche sp.	-	-	-	-	-	-	-	-	-	-	12	15	8	52	64	24	30	68	15
Brachycentrus sp.	-	-	-	-	-	9	2	28	2	12	83	73	140	216	2656	30	51	400	6
Hydroptila sp.	-	-	-	-	-	-	-	-	2	6	15	3	10	-	-	-	5	12	1
Agraylea sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	4
Mayatrichia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
Glossosoma sp.	-	-	-	-	-	1	44	12	8	24	110	10	170	16	24	13	-	-	-
Arctopsyche sp.	-	-	-	-	-	18	8	68	26	112	15	3	-	12	112	-	10	-	-
Dicosmoecus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psychomyia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beetles																			
Optioservus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Cylloepus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agabus sp.	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
True Flies																			
Blackflies																			
Simulium sp.	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	3	66	224	3
Prosimulium sp.	-	-	-	-	-	-	-	-	-	-	-	1	-	16	-	1	10	80	-
Empididae	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Tipulidae	-	-	-	-	-	-	-	-	-	-	1	-	-	4	-	-	1	-	3
Atherix	-	-	-	-	-	1	1	1	-	8	-	1	7	-	1	-	1	-	-
Tabanidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stratiomyidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Midges																			
Pseudochironomus sp.	-	-	3	1	24	-	-	-	-	-	-	-	-	-	-	9	-	32	3
Spaniotoma sp.	8	14	-	-	-	5	22	16	6	14	80	6	12	12	16	22	42	88	20
Polypedilum sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	8	20	40	-
Pentaneura sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Cricotopus sp.	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	15
Tendipes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cryptochironomus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biting Midges																			
Bezzia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lepidoptera																			
Elophila sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scuds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Snails	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludgeworms	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	4	-
Number of Kinds	3	4	5	2	4	8	10	8	9	10	14	14	10	10	10	12	19	15	14
Number per sq. foot	12	20	9	2	31	47	154	877*	98	284*	368	191	761*	488	3034*	205	539	1260*	166

*Number of organisms per square yard

TABLE 28 ANIMAS RIVER (Cont.)

789.6-249.-	28.3 Center Ar-17	28.0 Sq. Yd. AR-17	16.2 Center AR-16A	16.2 Rt. Bk. AR-16A	16.2 Sq. Yd. AR-16A	10.7 Headend AR-16	10.7 Lower Riffle AR-16	1.0 AR-15	1.0 Head of Riff. AR-15	1.0 Sq. Yd. AR-15	107-0.5 Cement Cr. CC-26	106-4.0-0.5 Mineral Cr. MI-27B	106-3.0 0.5 MI-25A	106-0.5 MI-25	57.2-0.5 Lighter Cr.	57.2-0.5 Lighter Cr.	39.0-1.0 Florida Cr.	39.0-1.0 Florida Cr.
Stoneflies																		
Brachyptera	1	1	-	2	16	7	-	3	6	4	-	-	-	-	-	-	-	-
Isoperla	-	-	-	-	-	-	-	-	-	-		3	-	-	-	-	-	-
Pteronarcys sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nemoura sp.	-	-	-	-	-	-	-	-	-	-		5	-	1	-	-	-	-
Paraperla sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isogenus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Alloperla sp.	-	-	-	-	-	-	-	-	-	-		7	-	1	-	-	-	-
Mayflies																		
Heptagenia sp.	1	-	1	3	-	5	-	7	4	4	-	-	-	-	-	-	32	64
Ephemerella sp.	1	12	-	6	72	2	2	-	-	4	-	-	-	-	-	-	-	16
Baetis sp.	20	49	3	50	32	110	3	25	50	12	-	-	-	-	-	-	60	56
Pseudocloeon sp.	27	71	30	128	88	79	46	124	116	135	-	-	-	4	-	-	180	168
Rhithrogena sp.	?	-	-	-	8	21	-	-	12	-	-	-	-	-	-	-	-	-
Tricorythodes sp.	-	-	-	1	-	3	1	5	-	-	-	-	-	-	-	-	192	312
Choroterpes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	64
Cinygmula sp.	-	-	-	-	-	-	-	-	-	-	-	24	-	-	-	-	-	-
Ironodes sp.	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-
Caddisflies																		
Rhyacophila sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydropsyche sp.	44	30	2	47	336	20	9	62	168	272	-	-	-	-	-	4	120	32
Cheumatopsyche sp.	37	40	6	16	160	41	7	32	122	200	-	-	-	-	-	-	60	60
Brachycentrus sp.	4	11	-	7	112	2	1	10	30	20	-	-	-	-	1	-	32	
Hydroptila sp.	3	2	-	-	16	-	3	2	2	-	-	-	-	-	-	-	60	-
Agraylea sp.	-	1	-	1	8	-	-	2	-	-	-	-	-	-	-	-	4	32
Mayatrichia sp.	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
Glossosoma sp.	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Arctopsyche sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-
Dicosmoecus sp.	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2	-	-
Psychomyia sp.	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Beetles																		
Optioservus sp.	-	-	-	-	16	-	-	1	-	-	-	-	-	-	8	-	-	-
Cylloepus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agabus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
True Flies																		
Blackflies																		
Simulium sp.	13	2	2	17	-	88	1	1	2	-	-	-	-	-	-	-	-	-
Prosimulium sp.	2	-	-	-	16	20	-	-	-	-	-	-	-	-	-	-	-	-
Empididae	-	1	-	-	16	-	-	-	-	2	-	-	-	-	18	-	-	-
Tipulidae	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Atherix	-	-	-	-	8	-	-	-	-	-	-	-	-	-	1	2	-	-
Tabanidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stratiomyidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Midges																		
Pseudochironomus sp.	5	-	-	-	-	-	5	6	24	44	-	2	-	-	-	-	40	-
Spaniotoma sp.	12	6	24	114	488	30	65	100	38	52	8	3	4	8	67	18	60	120
Polypedilum sp.	-	4	-	43	240	41	-	10	30	88	-	-	-	-	-	-	24	80
Pentaneura sp.	-	-	-	-	-	-	-	-	2	-	-	-	-	-	5	-	-	8
Cricotopus sp.	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tendipes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cryptochironomus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biting Midges																		
Bezzia	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Lepidoptera																		
Elophila sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scuds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Snails	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludgeworms	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	2	28	120
Number of Kinds	14	13	8	14	16	14	13	15	14	12	2	10	1	6	8	6	14	14
Number per sq. foot	172	230*	70	436	1632*	469	146	390	606	837*	9	49	4	16	112	30	904	1198

TABLE 29 - SAN JUAN RIVER BASIN SURVEY
MCELMO CREEK
Bottom Fauna Data - No. Per Sq. Ft.

July 1966

789.6-165.8	0.5 MC-11	35.5 MC-12	45.4 MC-13	50 MC-14
Mayflies				
Baetis sp.	1	-	-	-
Tricorythodes sp.	2	6	-	4
Caddisflies				
Hydropsyche sp.	24	3	-	13
Cheumatopsyche sp.	39	3	-	-
Agraylea sp.	1	-	-	6
Arctopsyche sp.	-	1	-	-
Beetles				
Optioservus sp.	-	-	-	1
True Flies				
Blackflies				
Simulium sp.	5	3	-	-
Prosimulium sp.	7	4	-	-
Midges				
Spaniotoma sp.	-	1	40	17
Cricotopus sp.	-	2	250	40
Polypedilum sp.	-	-	10	-
Biting Midges				
Bezzia sp.	2	-	2	-
Psychoda sp.	-	-	1	-
Empididae sp.	-	-	-	3
Snail	-	-	1	-
Sludgeworms	-	-	1800	2
Number of Kinds	8	8	7	8
No. Per Sq. Ft.	81	23	2104	86

Table 30. Colorado River from Pierce Canyon to the Mexican Border Sampling Stations

Mileage	Station Description
0021:30	Just upstream of Morelos Dam at Yuma, Ariz.
0023:20	Just upstream of the Welton Mohawk by-pass channel
0027:00	100 yd. downstream of Yuma Municipal Waste Outfall
0028:00	Upstream of Yuma Municipal Waste outfall
0034:50 - 2	Gila River - near Gila Cemetery
0044:00	Just downstream of Laguna Dam
0050:00	Just upstream of Imperial Dam
0101:50 - 2	Palo Verde Drain - downstream of the town of Palo Verde
0101:50 - 17	C-03 canal 1 mile north of Ripley, Col.
0101:50 - 17.2	West drain 1 mile north of Ripley, Col.
0101:50 - 17.9	Township Drain 1 mile north of Ripley, Col.
0101:50 - 18.1	Palo Verde drain 1 mile north of Ripley, Col.
0101:50 - 25.1	West side drain 1 mile northwest of Blythe, Col.
0101:50 - 25.2	C-03 canal 1 mile northwest of Blythe, Col.
0101:50 - 28.0	East side drain 1 mile northeast of Blythe, Col.
101:50 - 28.2	Palo Verde Canal 1 mile northeast of Blythe, Col.
0101:50 - 38	Palo Verde Canal inlet at the Palo Verde diversion dam
0139:60 - 1.5	Secondary drain of the Col. R. Indian Reservation near the Palo Verde diversion dam
0139:60 - 1.6	Primary drain of the Col. R. Indian Reservation near the Palo Verde diversion dam
0139:60 - 36	Canal 1 mile northwest of Poston School
0139:60 - 39	Canal at Col. R Indian Reservation Road Crossing 6 miles southwest of Parker, Ariz.
0139:60 - 50	Inlet to Col. R. Indian Reservation canal 2 miles northeast of Parker, Ariz.
0189:00	Swim beach just upstream of the Col. R. Indian Reservation northern boundary
0196:00	Col. R - at Giers Wash
0198:00	Col. R at Parker Dam
0199:20 - 38.00	Bill Williams River downstream of Almo Dam site
0199:20 - 40.00	Bill Williams River - upstream of Almo Dam site

Table 30 Cont.

Mileage	Station Description
0200:65	Metropolitan Water District intake
0358:00	L. Mead at Saddle Island Marina
0359:00	Las Vegas Wash Marina
0360:00	Park Boundary at Las Vegas Wash Marina
0362:10	Mouth of Las Vegas Wash
0362:10 - 9.5	Las Vegas Wash at North Shore Road
0362:10 -15.2	Las Vegas Wash Road Crossing North of Henderson at Gaging Sta.
0362:10 -16.7	Las Vegas Wash at confluence of S & P effluents
0362:10 -18.1	Clark County S & P effluent
0362:10 -19.7	Las Vegas S & P effluent
0366:50 - 23.0/20.9	Muddy River at Glendale, Nev.
0386:50 - 48.4	Virgin River at Riverside, Nev.
0386:50 - 71.0	Virgin River at Littlefield, Ariz.
0386:50 - 109	Virgin River at St. George
0413:90	L. Mead in Gregg Basin surface and bottom sample
0430:00	L. Mead in Pierce Canyon surface and 100' sample

TABLE 31 COLORADO RIVER - PIERCE CANYON TO THE MEXICAN BORDER, APRIL 11-2[illegible], 1966

BOTTOM ORGANISMS, ALGAL AND CHEMICAL DATA

					Las Vegas Wash					Muddy River	Virgin River	Virgin River	Virgin River				
	0358:00	0359:00	0360:00	0362:00	0362:10 1.6	0362:10 6.4	0362:10 11.2	0362:10 11.2-1.4	0362:10 11.2-2.0	0385:50 20.90	0386:50 -15	0386:50 -37	0386:50 109.00	0413:90 Surface	0413:90 100' Depth	0430:00 Surface	0430:00 Bottom
Mayfly nymphs																	
Ameletus																	
Isonychia										25	•	4	•				
Tricorythodes										15							
Cinygma										54	•						
Ephemerella												4	•				
Caenis												1	•				
Baetis																	
Caddisfly larvae																	
Potamyia																	
Agraylea																	
Hydropsyche										•	•		•				
Cheumatopsyche																	
Aquatic Caterpillars																	
Elophila										3							
Blackfly larvae																	
Prosimulium				•						93	•	30	•				
Simulium																	
Beetles																	
Neoelmis										8							
Agabus																	
Hellgrammites																	
Corydalus cornutus										2							
True Flies																	
Spaniotoma				•													
Tendipes							•										
Pentaneura						96				2							
Pseudochironomus										21	•						
Polypedilum																	
Cricotopus										2							
Cryptochironomus										3							
Pelopia																	
Clams																	
Sphaeriidae																	
Sludgeworms																	
Tubificidae						2	4			8			•				
Number of Kinds						2	2			12	3	4	6	0	0	0	0
Number/sq. foot						98	4			236	3	39	6	0	0	0	0
Phytoplankton Algae per ml	300	-	39,300	100	600	500	11,000	3700	8900	100	500	-	100	100	100	50	50
Attached Algae Number per sq in	18,570	-	-	3,435,250	-	417,613	-	231,000	417,600	1,517,000	-	15,000	-	-	-	-	-
Chemical Data mg/l																	
NH_3-N	< 0.1	0.2	0.2	< 0.1	< 0.1	< 0.1	12.5	6.0	16.0	0.2	0.2	0.9	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
NO_3-N	0.6	0.2	0.2	11.0	9.2	3.8	1.0	2.3	0.1	0.5	0.5	0.5	0.5	0.5	0.9	0.9	0.9
Organic N	0.3	0.8	0.8	0.3	0.7	1.3	5.5	2.9	-	0.6	1.0	1.1	0.8	0.6	0.3	0.5	0.8
µg/l																	
Sol P	10	5	10	4250	4500	4850	7000	10,000	11,000	45	25	30	50	5	5	15	15
Total P	20	50	24	7000	7000	9500	12100	12,000	12,400	300	600	495	415	40	20	350	170
Flow cfs						31				38		246		13,200			

TABLE 31 COLORADO RIVER - PIERCE CANYON TO THE MEXICAN BORDER, APRIL 11-22, 1966.

BOTTOM ORGANISMS, ALGAL AND CHEMICAL DATA (Cont.)

River Mile	0021:30	0023:20	0027:00	0028:00	Gila R. 0034:50 2	0044:00	0050:00	Palo Verdi Drain 0101:50 -2	C-03 0101:50 -17	West Drain 0101:50 -17.2	Town-ship Drain 0101:50 -17.9	Palo Verdi Drain 0101:50 -18.1
Mayfly nymphs												
Ameletus	16	•		2	•	8		•				
Isonychia												
Tricorythodes						•						
Cinygma												
Ephemerella												
Caenis												
Baetis												
Caddisfly larvae												
Petasyia	46	•		113	•	•		23				
Agraylea								•			338	
Hydropsyche												
Cheumatopsyche												
Aquatic Caterpillars												
Elophila						•						
Blackfly larvae												
Prosimulium	1			21	15	•						
Simulium					•							
Beetles												
Hecolmis												
Agabus												
Hellgrammites												
Corydalus cornutus												
True Flies												
Spaniotoma	3	•	•		5	•		•		22		
Tendipes	7			4		7		30		10		
Pentaneura	3			8	•	•		8				
Pseudochironomus								11			31	
Polypedilum	3					14						
Cricotopus	3							30				
Cryptochironomus		12					2	8				
Pelopia						3						
Clams												
Sphaeriidae		•			•	•	17	8	127			36
Sludgeworms												
Tubificidae	3	108	•		•	•		14	7			36
Number of Kinds	9	6	2	3	8	12	2	10	2	2	2	2
Number/sq. foot	87	120	2	142	26	40	19	152	134	32	369	72
Phytoplankton Algae per ml	3800	6300	1200	3600	33,800	2600	800	600	400	700	600	800
Attached Algae Number per sq. in.	1,807,500	30,680	-	-	-	-	-	4,943,300	-	-	-	-
Chemical Data mg/l NH3-N	<0.1	0.8	1.8	<0.1	0.2	<0.1	<0.1	0.2	0.1	<0.1	0.2	0.2
NO3-N	0.6	0.4	0.3	0.4	0.0	0.5	0.5	0.4	0.3	0.8	0.3	0.3
Organic N	0.6	0.6	1.0	0.5	0.8	0.5	0.5	0.6	0.3	0.7	0.7	0.7
µg/l Sol P	18	85	940	24	80	10	17	11	8	5	5	7
Total P	40	138	1200	63	70	27	35	93	8	68	89	97
Flow cfs	933				30							

River Mile	West Side Drain 0101:50 -25.1	Canal C-03 Inlet 0101:50 -25.2	East Side Drain 0101:50 -26	Palo Verdi Canal 0101:50 -26.2	Palo Verdi Inlet 140.2	Sec. Drain 0139:60 -1.5	Pri. Drain 0139:60 -1.6	Canal 0139:60 -36	Canal 0139:6 -39	Inlet 184.0	182.5	0196:00	0198:10	Bill Williams 0199:20 38.00	Bill Williams 0199:20 40.00	0200:6
Mayfly nymphs																
Ameletus					•							2		•	•	
Isonychia																
Tricorythodes				•	•									•	•	
Cinygma																
Ephemerella																
Caenis					•											
Baetis															•	
Caddisfly larvae																
Petasyia					•	•								•	•	
Agraylea																
Hydropsyche																
Cheumatopsyche														•	•	
Aquatic Caterpillars																
Elophila												2				
Blackfly larvae																
Prosimulium										3					•	
Simulium														•		
Beetles																
Hecolmis																
Agabus															•	
Hellgrammites																
Corydalus cornutus																
True Flies			•													
Spaniotoma	16	7		•		•	•	•		7		14		•	•	
Tendipes	20		6			72	195		4		3					
Pentaneura																
Pseudochironomus	•		•				15									
Polypedilum						8		10	4		3			•		
Cricotopus										2						
Cryptochironomus								10								
Pelopia											17					
Clams																
Sphaeriidae	80	15	80	•	•	•	5		16	197		87				•
Sludgeworms																
Tubificidae	48	8	88	•		36		2	100	12	3	3		•	•	
Number of Kinds	5	3	5	4	3	6	5	3	4	6	4	4		8	9	1
Number/sq. foot	105	30	116	49	3	136	238	24	124	230	26	41		8	9	1
Phytoplankton Algae per ml	500	400	750	-	200	2700	200	300	50	50	400	100	300	250	300	350
Attached Algae Number per sq. in.	-		-		274,400	992,750	-			1,268,000						
Chemical Data mg/l NH3-N	0.1	0.1	0.3	-	<0.1	0.1	0.8	<0.1	<0.1	0.13	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
NO3-N	0.4	0.3	0.6	-	0.6	0.4	0.1	0.4	0.3	0.6	0.6	0.6	0.3	0.1	0.1	0.4
Organic N	0.4	0.6	0.4	-	0.4	0.5	0.8	0.3	0.3	0.5	0.4	0.4	0.3	0.4	0.3	0.4
µg/l Sol P	5	5	3	-	3	25	87	10	<3	<3	<3	7	<3	30	7	3
Total P	42	51	61	-	99	58	41	78	3	10	10	10	3	95	80	3
Flow cfs					1570					770			11,800			

*Collected in qualitative sample, counted as one in total

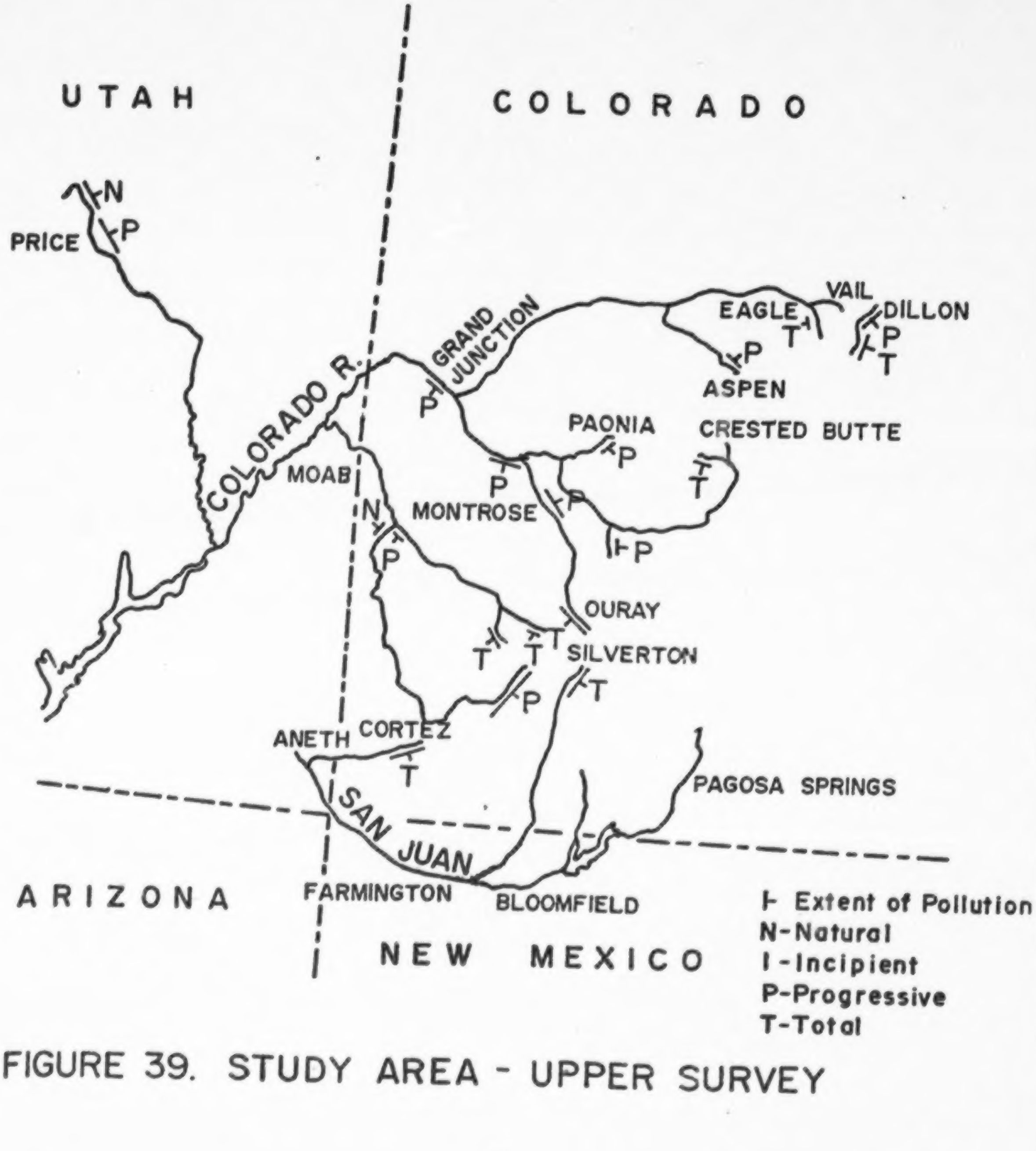
UTAH
COLORADO
N
PRICE
P
COLORADO R.
GRAND JUNCTION
P
VAIL
EAGLE
DILLON
T
P
P
T
ASPEN
PAONIA
CRESTED BUTTE
P
P
T
MOAB
N
MONTROSE
P
P
P
OURAY
T
T
T
SILVERTON
P
T
ANETH
CORTEZ
T
PAGOSA SPRINGS
SAN JUAN
ARIZONA
FARMINGTON
BLOOMFIELD
NEW MEXICO
⊢ Extent of Pollution
N-Natural
I-Incipient
P-Progressive
T-Total

FIGURE 39. STUDY AREA - UPPER SURVEY

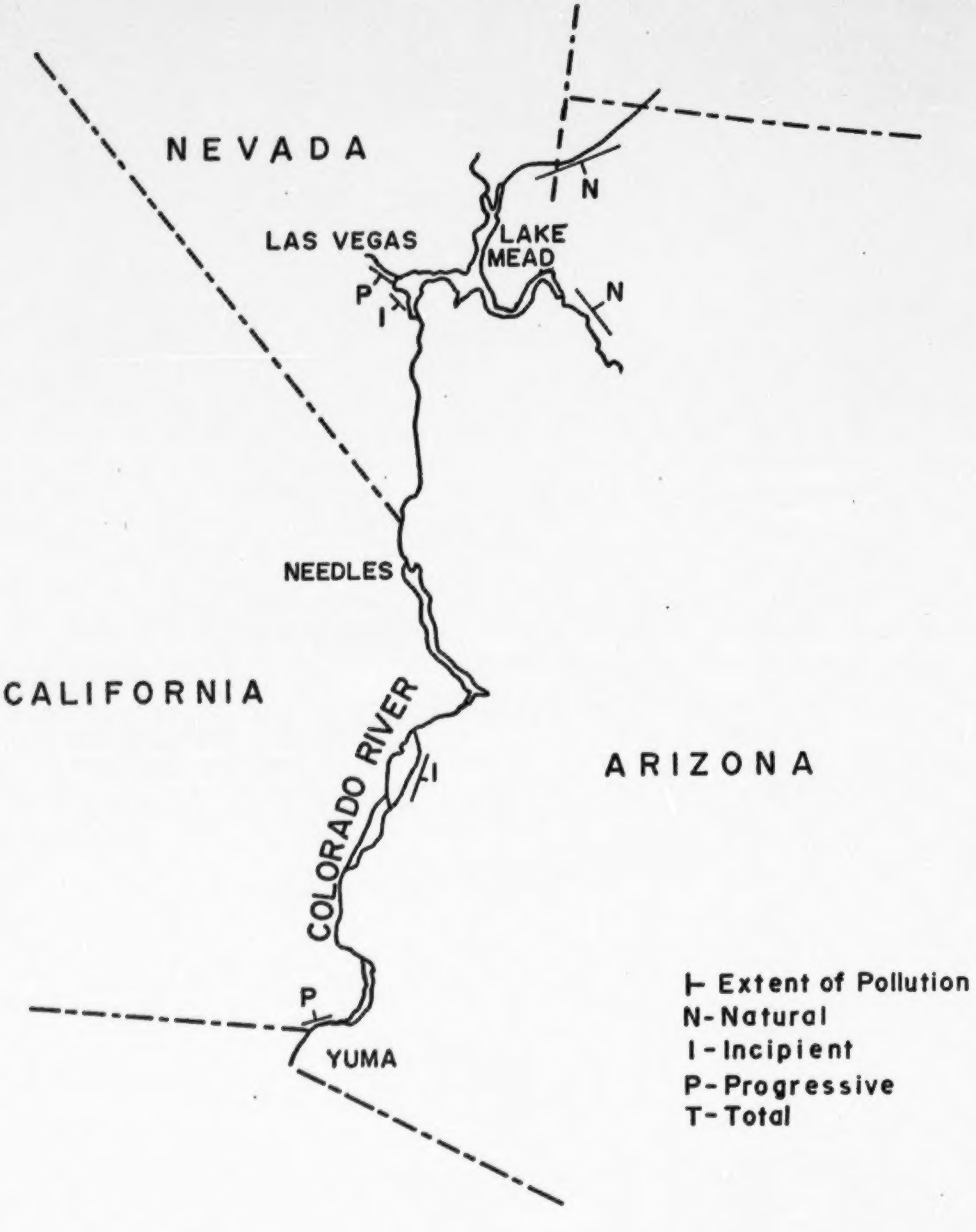
NEVADA
LAS VEGAS
LAKE MEAD
P
I
N
N
NEEDLES
CALIFORNIA
COLORADO RIVER
I
ARIZONA
P
YUMA
⊢ Extent of Pollution
N-Natural
I-Incipient
P-Progressive
T-Total

FIGURE 40. STUDY AREA - LOWER SURVEY